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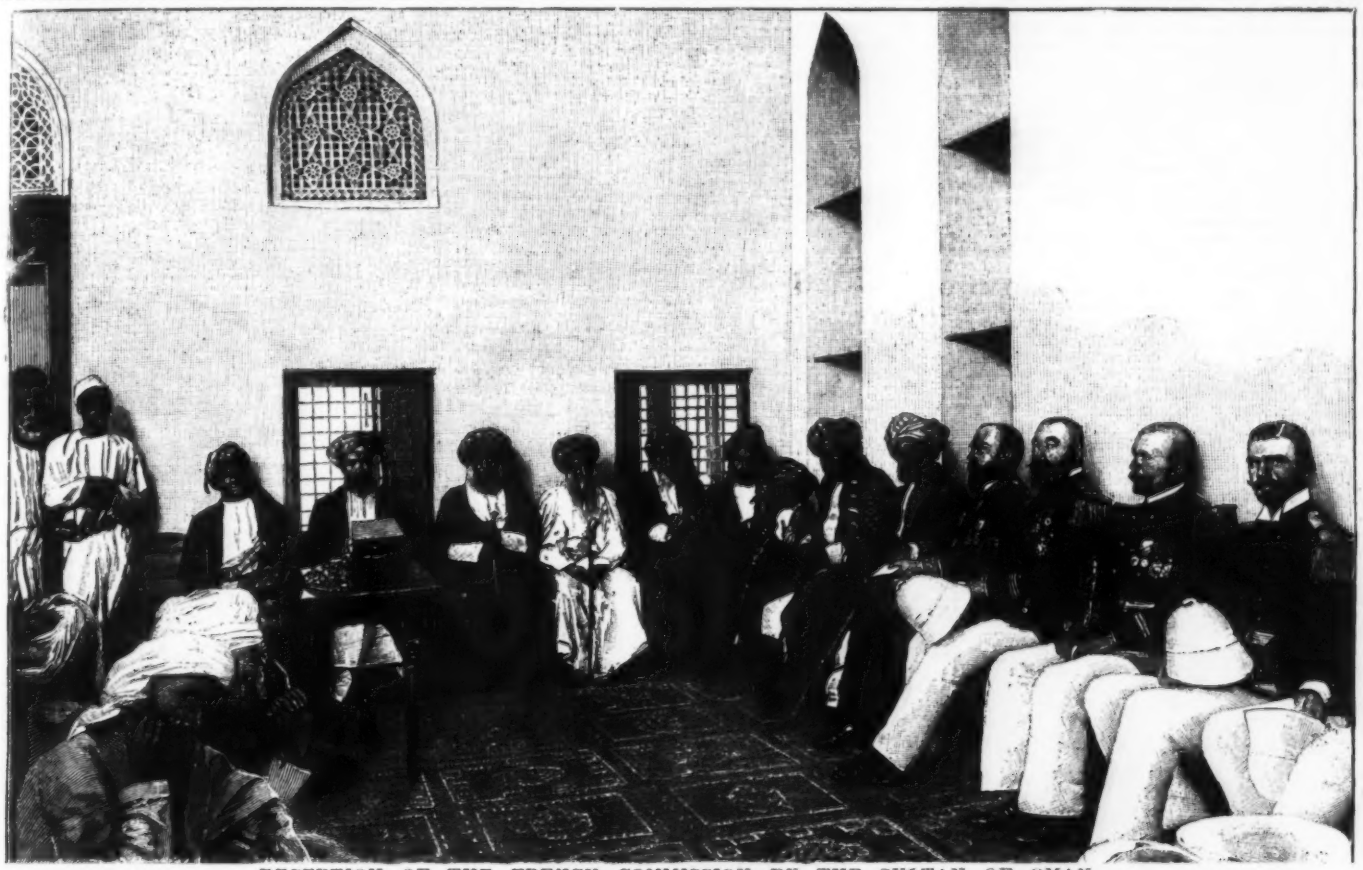
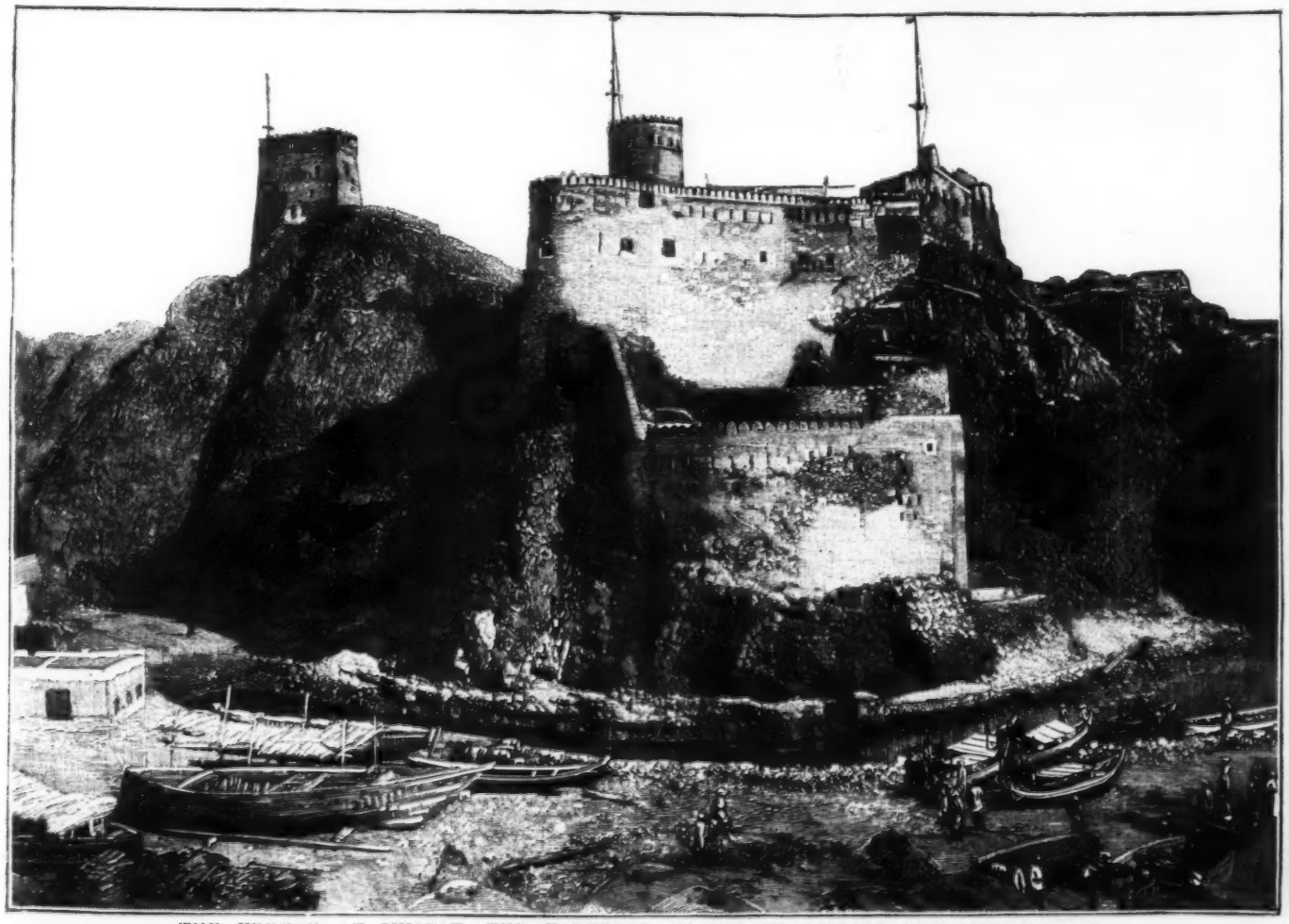


RECEPTION OF THE FRENCH COMMISSION BY THE SULTAN OF OMAN.



THE FRENCH AT MUSCAT.—THE FORTRESS OF MIRAMI DJIBALI, OPPOSITE MUSCAT.

THE FRENCH AT MUSCAT.

THE recent incident at Muscat is still fresh in the public mind. The English desired to be masters of the Persian Gulf, while the French wished to establish a coaling station near Muscat, a town admirably situated for that purpose, near the entrance to the gulf. The French obtained permission from the Sultan to establish their station at Bender-Sissek, whereupon the English proclaimed the conquest of Arabia by France. People almost feared at one time a second edition of Fashoda; but this time French honor is safe, and everything has been arranged.

The French were very conciliatory in the treaty signed March 21 relative to Africa; and so to recompense them the English tolerated this coaling station. Thus France has been successful in her operations in Asia, although those in Africa did not end happily.

Muscat, a city of about 30,000 inhabitants, is the capital of Oman, the seat of the Arabian empire, which was so powerful up to 1856, and which at that time comprised, besides its 1,863 miles of coast on the Arabian peninsula, the isles of the Persian Gulf, the ports of Baluchistan and Persia, and most of the old Portuguese settlements on the coast of Africa, including Mozambique and Zanzibar. In 1857 Zanzibar separated from the empire, and the authority of the sovereign of Muscat rapidly lessened. The fleet of Oman, once the most powerful of the Indian Ocean—it consisted of thirty-five frigates constructed after European models—is now only a recollection.

France has always been on excellent terms with the rulers of Oman, and has enjoyed all the privileges which were accorded to England.

One of these Franco-English arrangements, the secret of which the French diplomats still hold, caused France to abandon, in 1890, the rights which she had in Zanzibar, but she carefully guarded her liberty of action at Muscat. When the English obtained a coaling-station and kept a warship there almost continually, for the purpose of prohibiting all foreign influence from restraining them, France thought that it was time to affirm her rights and to act, if she did not wish to see the Persian Gulf turned into an English lake. Thereupon she created a consulate at Muscat, and appointed as consul M. Ottavi, who had rendered her great services at Zanzibar as consul. Then French warships appeared on the coast of Oman at regular intervals, to salute the Sultan and assure him of France's sympathies.

The efforts of the French terminated favorably, and at the end of last year the dispatch boat "Scorpion" left for Muscat with a commission which carried to the Sultan presents from the government, and examined the coast for a place to use as a coaling-station.

Our front page illustration shows the reception of the commission by His Highness Seyyid Feysal ben Tourki, the ruling sovereign of Muscat. He gave the commission a cordial welcome, and appeared greatly pleased by the presents they brought, which consisted of silks, Sèvres vases, Gobelins tapestries, and gold and silver ware. The Sultan afterward visited the French ships and was high in his praises of the officers and sailors.

His Highness has all the experience of a man forty years of age who has governed a long time. He did not make any allusion as to how England stood; but he accepted events which have taken place, with the philosophical indolence so characteristic of him as an Asiatic ruler and follower of Mahomet.

The power of the Sultan extends over a population of from 1,600,000 to 1,800,000 inhabitants, and his revenues, that is to say, the revenues of the state, for he is the state, reach and even surpass $2,400,000. He lives with some degree of pomp, consoling himself for misfortunes and regret for the ancient splendor of his empire, among his numerous children and still more numerous wives. He presented a part of his family, consisting of his sole heirs, to the commission, and our photograph shows them with him, the boy on the right being his oldest son and successor, Seyyid Felzour ben Feysal.

Muscat is situated at the end of a circular bay whose entrance is closed by an island and is bordered by reddish precipitous rocks. These formidable rocks are topped with towers and fortifications, which, although they date only from the time of the Portuguese, render the city impregnable. All this scenery is very picturesque.

The principal fortification is the Mirami Djibali fortress, which commands the roadstead on the northwest. In the interior of the fortress is an old chapel which is a very curious specimen of the Portuguese architecture of the sixteenth century.

The fort of Muscat is extensive, and its situation at the extreme end of Arabia, opposite India, and at the entrance to the Persian Gulf, has made it at all times a natural emporium between India, Arabia, and Persia.

It is an excellent advantage for the French nation to have a place in which to recoal at the very doors of Muscat. France was without a place of shelter on the Arabian Sea. In the whole Indian Ocean, from Ceylon to the Gulf of Aden, France had no port except Obock on the African coast and Mahé on the Asiatic coast.

In the upper Indian Ocean French vessels had no place to put into for refuge, but now a third point has been acquired. This is an advantage, but a small one, because of the power of the English in this part of the world.

The fact that a port is henceforth officially open to France in Oman should be of great interest to French sea captains and commercial men who have already turned their attention toward Africa and gone as far as Obock and Abyssinia. Parallel to the Red Sea, the Persian Gulf opens for them a district which should be looked into.

Oman is the country of importation and exportation in the great trade with Bombay, Calcutta, Zanzibar, etc. The English carry on a great deal of business there, and the Germans are beginning to enter it. From the point of view of colonial achievement, Oman is also a country of the future. Everything has yet to be organized and to be accomplished in this region, which was so flourishing and is yet to become so again. The country is, with its numerous oases, like a fairy-land. At the end of the Gulf of Bassorah stands Muscat. You have entered well into the country of the "Arabian Nights." The bad genii have cast a spell over Oman, but a prince must come from over the sea "on a horse of bronze" to awaken the enchanted earth from the spell.

This at least is what the Sultan, who loves legends, told the English consul one day, and the latter replied that the horses of bronze to-day are the English armorclads and the expected prince is the Prince of Wales.—L'Illustration.

THE SULTAN AND HIS HEIRS.

THE ELECTRIC LIGHT BATH.

DR. J. H. KELLOGG in a paper read at the last meeting of the American Medical Association, and just published in the journal of that body, calls attention to the electric light bath as a means of applying heat to the body as a therapeutic agent. He refers to a previous paper read by him at a meeting of the American Electro-Therapeutic Association, in which experiments were mentioned and comparisons made of the effects obtained with those of the Turkish and Russian baths. The general conclusions were as follows: (1) The electric light bath stimulates the elimination of carbon dioxide in a very marked degree. In a bath lasting thirty minutes, the percentage of elimination of the dioxide during the last ten minutes was 5·13, as compared with 3·60, the average elimination before the bath. In a Russian bath the percentage of elimination was 3·96; in a Turkish bath of thirty minutes' duration, 4·01. (2) The elimination of nitrogenous wastes, represented by urea, and also the elimination of total solids, was greatest in the Russian bath and least in the electric light bath, doubtless the result of excessive skin activity. (3) The amount of perspiration produced by the electric light bath was fully double that induced by the Turkish bath in the same length of time. The time required for the first appearance of perspiration was in the electric light bath about one-half that in the Turkish and Russian baths. The reason for this was apparent from the fact observed by Bouchad, that perspiration begins when the temperature of the blood has risen 0·7° F. above the normal.

The author in again calling attention to the subject says that he does not consider that there is any specific effect obtainable from the electric light which would not be derived from any equally efficient source of radiant heat, and on this account he would prefer to use the term radiant heat bath rather than electric light bath, as the former term leaves room for the employment of any luminous source of heat which may possess properties identical with those of the electric light. A number of forms of apparatus are figured in the article, showing how the ordinary incandescent bulbs are arranged to produce the desired results. "In auto-intoxication," says the author, "the electric light bath is particularly helpful, as it not only stimulates elimination through the skin, but by penetrating the tissues, stimulates the process of oxidation, whereby toxins and waste matters are prepared for elimination.

"By accomplishing the results required of it in so short a space of time, the electric light bath is comparatively free from the exhausting effects which often result from the Turkish bath, the hot immersion bath and other modes of inducing perspiration. In the treatment of rheumatic diathesis there is no agent which so promptly affords relief as the electric light bath, since it adds to the powerful eliminative effects of heat the soothing influence of light upon sore muscles and joints. In obesity, likewise, the electric light bath proves a sovereign aid through the penetrating power of its rays, which stimulate the processes of disassimilation, while at the same time aiding the elimination of debris. Nervous headache, or migraine, now pretty generally recognized as a toxemia, yields readily to the systematic employment of the electric light bath in connection with the proper regulation of diet.

"The electric light bath enjoys the great advantage over other methods of applying heat in that it produces strong atonic effects, at the same time that it encourages powerful elimination. As a prophylactic, the electric light bath possesses a high value, especially for persons who are compelled to lead a sedentary life, such as teachers, doctors, lawyers, preachers, judges and professional men generally, and to a still greater degree by the majority of women, and which necessarily results sooner or later in disease and premature death from the accumulation within the body of those poisons which are destroyed or thrown off through active exercise in the open air. The electric light bath is the best of all substitutes for muscular activity; for persons whose business necessarily keeps them confined indoors, it is the most invaluable means of maintaining sound health. . . . In this country a vast number of people, especially dwellers in cities, are daily suffering from the deteriorating influence of a sedentary life, to whom the electric light bath, combined with a cold shower bath, would prove an inestimable boon."

In conclusion, he says: "After having employed this bath in several thousand cases, I feel justified in urgently inviting the attention of the profession to test its value, and I feel sure that a study of its merits will lead to its practical application in the treatment of a great variety of chronic ailments, many of which so obstinately resist therapeutic measures."

LIQUID AIR.*

By Dr. W. HAMPSON, M.A. Oxon.

A GOOD deal of interest has lately been taken in liquid air. Connected as it is on the one hand with the refined scientific study of the properties of matter under rare and only recently attainable conditions, and on the other hand with the processes of refrigeration, which are becoming every day more important in the commercial world, there is in its production and properties plenty to attract the attention both of the student and of the business man. Its remarkable properties have lost nothing and gained a good deal every time they have been recapitulated, and in order that practical men who are not specialists in the subject may be enabled to avoid believing too much, without on the other hand rejecting too much, it will be well to make a brief statement of the facts in connection with the subject.

Those who have to do with refrigerating plant working with ammonia and carbonic acid are aware that no pressure, however great, will reduce these gases to the liquid state unless they are cooled at the same time to certain definite temperatures, about 130° C. in the case of ammonia, and about 31° C. in that of carbonic acid.

These temperatures are called the critical temperatures. Air also has its critical temperature, above which no pressure can possibly liquefy it, but in the case of air the critical temperature is very low, about —140° C. At this temperature a pressure of 39 atmospheres is required to liquefy air, but as lower temperatures are reached smaller pressures are sufficient to produce condensation, and at —191° C. air liquefies and remains liquid under normal pressure, as water does at +100° C. This temperature is, therefore, called the boiling point of liquid air, and is commonly understood when the temperature of liquid air is referred to.

It corresponds to 344° of frost on the Fahrenheit scale, and is twice as far below ordinary temperatures as boiling water is above them. In the liquid state air occupies $\frac{1}{850}$ part of its ordinary volume, or $\frac{1}{770}$ part of its volume as a vapor at its boiling point. Or, putting it in another way, if liquid air be vaporized and warmed to ordinary temperature, it will expand 800 times. Water converted into steam at its boiling point expands more than 1,700 times. The liquid is nearly colorless, and looks like water with a very pale blue tint, due to the oxygen, which is distinctly, though not strongly, blue. Its latent heat of vaporization is from 55 to 80 heat units on the Centigrade scale. It exhibits the ordinary properties of liquids, including capillarity. Inclosed in a vessel connected with a vacuum pump, it is without much difficulty cooled and frozen by reduction of temperature. The remarkable properties of the liquid and of other bodies at the same temperature are well illustrated by a number of experiments, which, with slight variations, have become familiar of late years at scientific lectures and demonstrations.

The possession of a means of readily obtaining intensely low temperatures, besides making it possible to perform many striking experiments, has greatly facilitated a special branch of scientific research, and, in consequence, it has long been a most desirable thing to make the production of extreme cold reasonably easy and economical.

Until recent years the method of producing liquid air has been very cumbrous and expensive. Those who are familiar with refrigerating apparatus will easily understand that the low temperature produced by an ammonia machine might be used, in the same way as the cooling water of the ammonia condenser, to condense a more volatile vapor, such as ethylene, in the coils of a second machine. The lower temperature produced by letting this liquid ethylene vaporize, as the ammonia does in the first machine, can be applied to the condensing coils of a third machine, in which air, compressed, and cooled by the vaporizing ethylene at a temperature of about —140° C., is thereby condensed. Of this condensed air, when it is released, a portion vaporizes, the remainder being a liquid at at-

* British Refrigeration.

mospheric pressure. This is called the "cascade method." It was practically invented by Pictet, and much improved in arrangement by Olszewski, while the knowledge obtained by Cailletet of the properties of volatile but condensible gases, notably ethylene, added to the facilities for working it. A large plant, with first-class machinery, was constructed on this method at the Royal Institution, and proved the means of making liquid air enough to provide many popular displays, and thereby spread more widely a knowledge of the subject. But it will be seen from the above description that the process was very costly, involving at least three sets of powerful compressors, the same number of condensers, and a very extensive system of connections, requiring a great deal of supervision. The complication depended largely on the necessity of creating artificial cold to extract the heat of compression at the lower temperatures. Early in 1895 the present writer devised a system of producing intense cold in which all the compression heat was extracted from the gas by water at normal temperatures, and the connection between that and the low temperatures was made by an interchanger, in which the gas passed through all intervening gradations of temperature. This made a single compressor suffice, and got rid of the necessity for intermediate refrigerating agents, such as nitrous oxide and ethylene. The apparatus, as illustrated in the diagrammatic section, is made by the Brin's Oxygen Company, of 69 Horseferry Road, Westminster, the well known compressors of oxygen and coal gas, and makers of compressed gas apparatus. The apparatus is compact and neatly finished. The same firm supply compressors suitable for working it, and cylinders of direct and purified air, oxygen, or carbonic acid, to be used in the alternative method referred to below.

In the illustration the compressed air enters by the small pipe, and the expanded air leaves by the large pipe at the top of the interchanger. The expansion valve is at the lower end of the coils in the vacuum vessel which acts as a receiver, and is furnished with a spiral tube, similar to that used by Prof. Dewar for the removal of the liquid. The valve is controlled by a hand wheel at the top of the apparatus, acting through a hollow steel spindle. The receiver may be removed with its contents by unscrewing the cap beneath the concentric glass cylinders, which, by inclosing layers of still air, give additional insulation. When the liquefier is worked with a cylinder instead of a compressor, the preliminary cooling by carbonic acid is done by passing in the cold vapor directly to those parts of the coils which have to reach the lowest temperature.

This apparatus depends upon a method by which a moderate amount of refrigeration, produced by the expansion of a gas, may be accumulated and intensified till it reaches the point at which the gas used becomes liquid under atmospheric pressure. The method consists in directing all the expanded gas, immediately *after* its expansion, over the coils which contain the compressed gas that is on its way to the expansion point. The cold developed by expansion in the first expanded gas is thus communicated to the on-coming compressed gas, which consequently expands from, and therefore to, a lower temperature than the preceding portion. It communicates in the same way its own intensified cold to the succeeding portion of compressed gas, which in its turn is made colder, both before and after expansion, than any that had gone before. This intensification of cooling goes on until the expansion temperature is far lower than it was at starting; and if the apparatus be well arranged, the effect is so powerful that even the small amount of cooling due to the free expansion of gas through a throttle valve may be made to liquefy air without using other refrigerants.

The amount of refrigeration due to free expansion was ascertained by Joule and Thomson, and is, in the first place, proportional to the fall of pressure. Air at 0·0° C. is cooled 0·29 of a degree C. for every atmosphere of pressure drop. This cooling, however, increases with the descent of the temperature from which expansion takes place, and the law within the limits of observation of these experimenters is that it is inversely proportional to the square of the absolute temperature. Thus, expansion of air from 4¼ atmospheres to 1, and from a temperature of 0·0° C., i. e., 274 absolute, gives about 1° of cooling in the air itself. But when the air expands from two-thirds of that absolute temperature, i. e., from —91° C., the cooling for the same pressure drop would be nine-fourths of 1°, or 2¼°.

The efficiency of the method depends upon the arrangement and construction of the coils and chamber forming the interchanger, in which the expanded gas takes up heat from the compressed gas. To make this action as perfect as possible, the conditions required are: Having a large surface of exposure between the compressed and expanded gases; having little thickness of material between them, and that little of high conductivity; having both compressed and expanded gas in small masses in close contact with the conducting material; having the total volume of the interchanger small, so as to expose little surface for the entrance of external heat; and having the total mass of coils and interchanger, which have to be cooled down with the gas, small and of little specific heat. These are all thermal advantages, and the arrangement of parts in the interchanger of the present apparatus is the most efficient hitherto designed for gases.

It has been attempted to obtain thermo-dynamic advantages by combining with a large difference of pressures a small ratio of pressures. This is done by expanding from the higher to an intermediate pressure, so as to have three pressures altogether. The action takes place in an interchanger of concentric spiral tubes, but at the cost of the thermal advantages named above; since the considerable intermediate pressure of gas in a pipe which incloses and is concentric with that for the high-pressure gas, and is itself inclosed in a third pipe for the low-pressure gas, necessitates great thickness and large mass of pipes, and prevents close coiling, thus increasing the size and mass of the interchanger, and diminishing the conductivity of the pipes.

In practice the thermal advantages are found to be the most important, so that the apparatus which embodies them not only liquefies air most quickly, but produces a given quantity of liquid with the smallest expenditure of power.

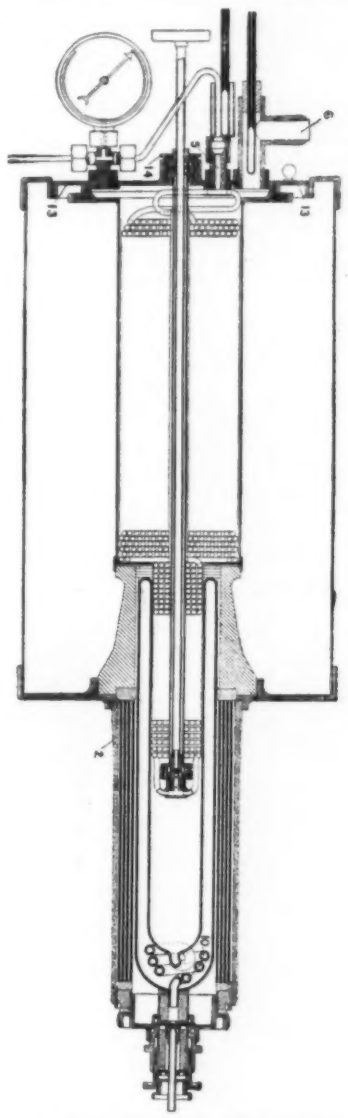
The apparatus is capable of working continuously with a compressor able to deliver air at a pressure of 80 atmospheres or over. It will also produce liquid from a single cylinder of air or oxygen. In the latter case the coils are previously cooled by passing over them cold vapor from a cylinder of liquid carbonic acid. The conditions of working in each case are as follows:

(1.) With a compressor.—Compression, 80 atmospheres or over; time for liquefaction of air, with 130 atmospheres, 10 minutes; time for liquefaction of air, with 120 atmospheres, 16 minutes; 150 atmospheres, 4½ minutes; indicated horse power employed, 3½; liquid air produced, 1·2 liters per hour; no preliminary refrigeration.

(2.) From a cylinder.—Preliminary cooling, cylinder of liquid carbonic acid; cylinder, oxygen, or air, up to 150 atmospheres; liquid produced, up to 225 cubic centimeters.

In both cases only one valve and one gage, requiring very little attention. The whole apparatus, including purifying cylinder, stand and connections, easily portable, and occupying two square feet of floor.

In the illustration the compressed air enters by the small pipe and the expanded air leaves by the large pipe, at the top of the interchanger. The expansion valve is at the lower end of the coils, in the vacuum vessel, which acts as a receiver. The valve is controlled by a hand wheel at the top of the apparatus, acting through a hollow steel spindle. Liquid may be withdrawn by the tap seen below the apparatus in the middle; or the receiver may be removed with its contents by unscrewing the vulcanite cap beneath the concentric glass cylinders, which, by inclosing layers of still air, give additional insulation. In the cylinder at the side of the support the compressed air from the pump passes through caustic potash, which removes moisture and carbonic acid, and so enables the apparatus to produce a clear liquid. When the liquefier is worked with a cylinder instead of a compressor, the preliminary cooling by carbonic acid is done by passing in the cold vapor to the bottom of the interchanger, whence it passes directly to those parts of the coils which have to reach the lowest temperature.



SECTION OF AIR LIQUEFIER.

It was with the liquid supplied by one of the above machines that Prof. Ramsay last year made his interesting discoveries of hitherto unknown gases in the atmosphere, belonging to the same series as the argon previously discovered by Lord Rayleigh and himself; and by the same means he was enabled to succeed in preparing a sample of argon, as well as of neon, in the pure state, and so obtaining definite information as to their physical properties. The same self-intensive method, when employed by Prof. Dewar, made it possible at last to liquefy both hydrogen and helium.

Now comes a very interesting development. A certain Mr. Charles E. Tripler, of New York, nearly two years after the detailed and illustrated publication of the self-intensive process, completed an apparatus which is a very close copy of my form of that process, but on a very much larger scale, using a compressor of fifty horse power. With this he has naturally been able to produce large quantities of liquid air—though not at a cheaper rate than the inventors of the process in their smaller plants. In conversations reported by writers in McClure's Magazine, of recent date, and in the Strand Magazine for April last, and copied in a number of weekly and daily periodicals, Mr. Tripler has definitely committed himself to the belief that he can make his apparatus produce without cost unlimited quantities of liquid air, to be used as a source of power.

The foundation on which all this rests is a mistake made by Mr. Tripler in the interpretation of some of his experiments with the apparatus, which he constructed on the European model—a mistake as gross and as vital as that which he had made before in his patent of 1898. In that patent he had overlooked the sensible heat due to compression, and the necessity of providing for its removal. In his recent experiments he has overlooked the latent heat given out by condensation and the necessity of providing for the removal of that heat. "We have just begun discovering things about the world," says Mr. Tripler, in his modest way. It is indeed very likely that by this time he has just begun discovering some elementary truths.

Working without this magical application, by which the liquid air is supposed to produce itself, and in the same humdrum way as myself and Dr. Linde, Mr. Tripler is able, like us, to produce liquid air at a cost, as he himself estimates, of about 10d. a gallon, or 1d. per pound. This pound, or pennyworth, of liquid air, expanding to the volume of thirteen cubic feet of air vapor at atmospheric pressure, will do a certain amount of work in an engine. Half a pound of water will also expand to thirteen cubic feet of steam at atmospheric pressure, and expanding from a smaller volume, will do more work than one pound of liquid air. But half a pound of steam, made in a good steam-raising apparatus, only costs $\frac{1}{10}$ part of a penny. For equal quantities of power, therefore, liquid air is mathematically more than two hundred and forty times as dear as steam, and practically the difficulties of handling it will make it compare more unfavorably still.

A few instances may be quoted of the wild statements with which Mr. Tripler's promises are bolstered up: "Liquid air, costing but a trifle, has an enormously greater expansive power than steam." Weight for weight, the trifle it costs is one hundred and twenty times the cost of steam, and its enormous expansive power is half that of steam. "Enough liquid air to run a steamer across the Atlantic could be made for £50," instead of using 2,500 tons of coal at a cost of £2,500; 2,500 tons of coal can be made to raise 25,000 tons of steam, and £50 would, at Mr. Tripler's own estimate of 10d. a gallon, provide less than six tons of air-vapor from liquid air, with an expansive force not so great as that of three tons of steam. "A quart of liquid air would blow up the rock of Gibraltar. The strongest and heaviest receptacle that could be made of steel would not hold a pint of this marvelous substance hermetically sealed." Ignorance and absurdity reach their limits in this statement. A steel tube of three inches diameter, and one and four-fifths inch bore, and fourteen inches long internally, if hermetically sealed at both ends, would hold a pint of liquid air within the limits of safety for compressed gases recommended by the Home Office Committee; and a similar tube of twice the length and open at the upper end would contain a quart, which with a suitable joint could be held down by the weight of less than eight cubic yards of the Rock of Gibraltar. In face of all this American newspapers have stated that companies were being formed for the manufacture and distribution of liquid air as an agent for producing power and refrigeration.

It may be roundly stated that liquid air will never be used commercially to produce either power or refrigeration, on account of its cost. That this is so is shown by the preceding comparison with the cost of steam for power and ice for cooling. The reason why it is so can be easily made clear by comparing the process of liquefying it with that of the most economical refrigerating agent known, namely, ammonia. Ammonia can be condensed at ordinary temperatures, and the latent heat given out in its liquefaction can, consequently, be removed by the cheapest and most convenient of all cooling agents—water. The critical temperature of air is as above stated —140° C. Consequently, if we compress it with the object of liquefying it, we must provide outside the condensing coils some cooling agent which is below the temperature of —140° C. There is no natural agent to take the place of water in acting as a cooler at that low temperature, and artificial cooling agents, such as ethylene at a low pressure, or methane, can only be provided at great cost. It is, therefore, hopeless, not merely on account of practical difficulties, but on account of natural impossibilities, to make cold by means of liquid air that would even approach the economy of that made through ammonia. And power from liquid air is under the same disadvantage as compared with power from liquid ammonia, which no one has been able, in spite of many attempts, to set up as a rival to steam.

The chief use for liquid air so far has been as an instrument of great power in scientific research. The chief possibilities before it in the commercial world are for processes in which something can be gained by passing a substance through very low temperatures as a temporary condition. Thus it has been shown above that when air is liquefied, the nitrogen tends to boil off first and leave fairly pure oxygen behind. This may be made a means of extracting oxygen from the air, if care be taken that both gases be removed from the apparatus in such a way as to avoid depriving the system of any considerable quantity of the cold produced in an expensive manner. As an explosive, liquid air, either confined in strong chambers, or, after losing much of its nitrogen, ignited in presence of a combustible, is not the absurd impossibility that it is as a source of commercial cold or power. But the difficulty of deciding the right moment to fire it, when exactly the right quantity of liquid has evaporated, the large proportion inevitably wasted, and the necessity for producing it by means of steam engines, compressors, water-coolers, and interchangers, involving much nicely adjusted and controlled apparatus, at or near the place and time of its employment, make it very unlikely to compete in quarrying and blasting, and still more in fighting, with explosives of greater power, which can be comfortably prepared at leisure long before-

hand, packed and stored without loss, and discharged with certainty and exactness at the moment required. The suggested employment of liquid air as a caustic in surgical operations is a good example of the absurdities proposed by dishonesty or ignorance in order to impress the public. Even such mild cooling agents as the ether spray have to be used with great care, since there is much danger of causing mortification beyond the tissues intended to be acted upon. The last proposal reported from Mr. Tripier is to set up a large institution for reducing the bodies of the dead to the extremely low temperature of liquid air. Perhaps this is one of the least foolish of the wild ideas suggested. As an insurance against fire, a prophylactic or precautionary measure for the benefit of those who, conscious that they have spent in deceiving the public the time allotted them in this world, entertain some not unreasonable apprehensions of finding an uncomfortably high temperature in the next, such a preparatory course of liquid air cooling might seem to have some advantages.

A FEW SPIDERS AND THEIR SPINNING WORK.*

ACCORDING to the Greek myth, Arachne was transformed into a spider by Pallas Minerva because she had boasted her superiority over that goddess in the use of the distaff: hence the Greek name for spider—Arachne.

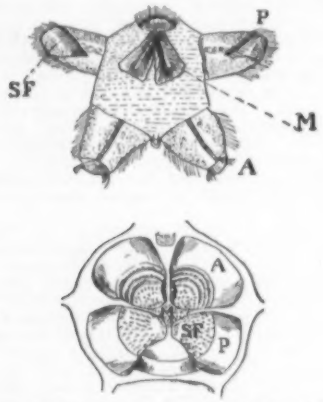


FIG. 1.—THE SPINNERETS WELL OPENED AND NEARLY CLOSED.

The classification of the various groups is based upon the web-making characteristics, and is divided into two principal groups—the sedentary spiders and the wandering spiders. The former group includes those which remain, for the most part, upon or within their webs, and take their prey by means of snares. This is further subdivided into the orbweavers, lineweavers, tubeweavers, and tunnel-weavers. From the orbweavers I will take a few examples and try to show what appear to be some of the chief characteristics of their spinning work.

The external spinning organs or spinning fingers are located under the posterior extremity of the abdomen, in most species. In some, however, they are placed a little more underneath or near the middle point of the abdomen. In the orbweaving species they consist ordinarily of six spinnerets. (Fig. 1.)

The three pairs differ somewhat in size and appearance—the middle pair being shorter and near together.

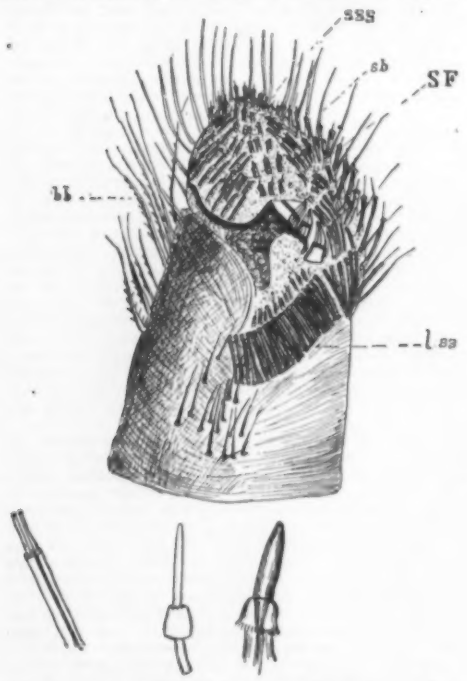


FIG. 2.—A POSTERIOR SPINNING FINGER AND INDIVIDUAL TUBES.

The posterior and anterior spinnerets have two joints; the middle are unjointed. They are movable, particularly the posterior and anterior pairs, and can be closed in upon each other until the tips touch at the spinning field. (Fig. 2.)

The spinning field is that portion of the tips and sides of the spinnerets on which are placed the tubes out of which the silk passes. In repose the spinnerets are generally closed, but in active operation they are thrown well open.

On each spinning field is placed a number of spools or tubes which are divided into two parts, of which the base is the thicker and sometimes the longer. They

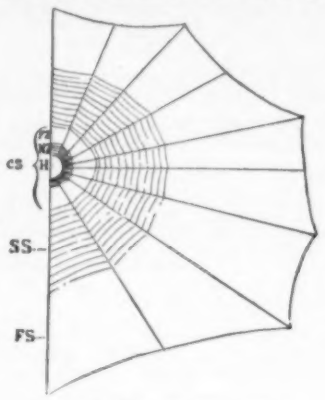


FIG. 3.—ORB DIVISIONS.

CS, central space: *FZ*, free zone; *NZ*, notched zone; *H*, hub. *SS*, spiral space. *FS*, foundation space.

are hollow tubes through which the delicate ducts connected with the silk glands convey the liquid silk to the surface. These groups of spinning spools are surrounded by hairs and bristles, which appear to have some important part in spinning.

Orbwebs are divided into two great groups—vertical snares and horizontal snares—while vertical snares are arranged under four subdivisions—full orb, sectoral orb, ray orb, and orb sector. (Fig. 3.)

The orb itself is further divided into the central space, the spiral space and the foundation space. The central

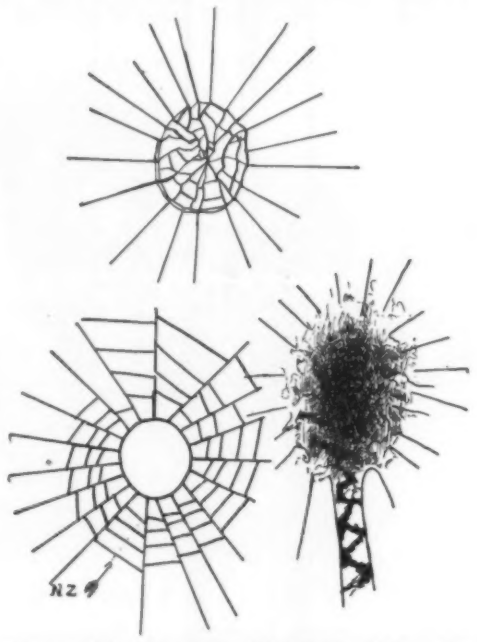


FIG. 4.—MESHED HUB, SHEETED HUB, AND OPEN HUB

space has three distinct parts—the hub, the notched zone, and the free zone. The hub usually corresponds in size to the length, including legs, of the spider that has woven it. The spider when waiting for its prey upon the snare is frequently, and at night generally, stretched upon this hub, and a close observation of its feet will show that the claws grasp and even draw out somewhat the lines which represent the radii continued. Every motion of the net is thus communicated by the taut lines to the sensitive feet; while the delicate hairs which cover the feet, and which are in contact with the lines, must greatly increase the sensitiveness of the creature to every movement. The spider is perhaps also aided in this natural telegraphy by the short line from the spinnerets to the hub. Yet the chief design of this habit would seem to be to hold it to its snare when it rushed after its prey, or to give a point of attachment for dropping out of the web in case of assault, and an equal advantage when it wishes to return. (Fig. 4.)

The hub may be meshed, sheeted or open. The meshed hub is wholly or partly covered by a series of irregularly shaped meshes through which may be often traced the continuation of the radii as zigzag lines. The sheeted hub is covered by a closely woven sheet of white silk. The open hub is entirely free from any spinning work and prevails largely in horizontal orbs.

The notched zone is a short series of spiral lines, usually from four to ten, immediately surrounding the hub. These spirals do not cross the radii directly, but each overlaps the radius longitudinally for a minute space at the point of crossing.

The free zone is that portion of the central space which lies between the notched zone and the spirals, and consists simply of the radii.

The use of the central space is thought to be protective. No part of it has viscid beads, and this permits the spider freer motion around the center without danger of entanglement upon the snare, and also decreases the chances of an insect's being entrapped there. Of course the further from the center the insect is entangled, the least damage necessarily ensues to the web, the longer it remains serviceable and the more easily is it mended. For the same reason the free zone may

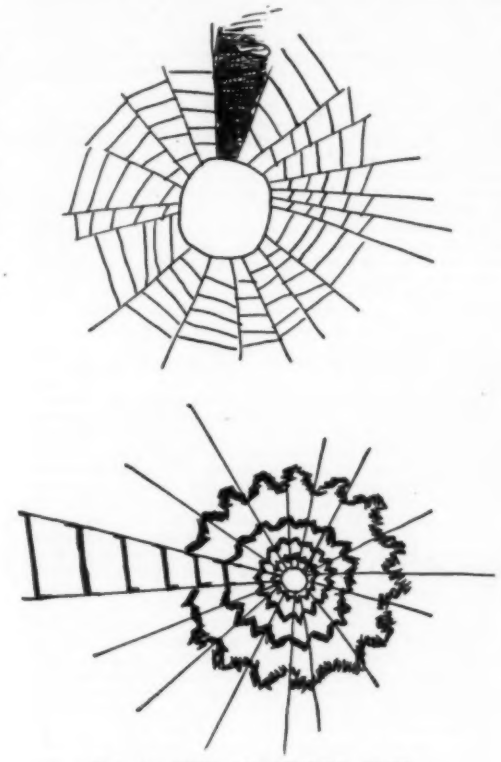


FIG. 5.—HUB OF SPIDER WEB.

be considered protective and gives the spider the further advantage of easy access to the under part of the snare, a convenience which is sometimes important. The purpose of the notched zone is to brace and hold in position the radii before the spirals are worked in and to strengthen the web. Certain genera further strengthen the notched zone by a plain band of white silk which extends between the two radii, along the perpendicular diameter upward from the hub to the spiral space. (Fig. 5.)

Sometimes the ribbon reaches both upward and downward from the hub as a zigzag cord. This peculiarity always prevails in the genus Acrosoma and in our familiar and beautiful representatives of the genus Argiope. Some species of Uloborous have a similar habit, but at times throw the cord entirely around the notched space, making a series of circles. These give a strikingly beautiful appearance to the web. The graceful lines and thick, white flossy texture of the bands showing in pretty contrast.

In the construction of the web the first line laid down by the spider is the frame or foundation line. This is accomplished by the spider crawling over and upon the objects upon which it purposes to spin the snare, drawing after it a line which in many places it fastens to the surface by pressing the spinnerets for an instant to the surface thereon. When these spin-

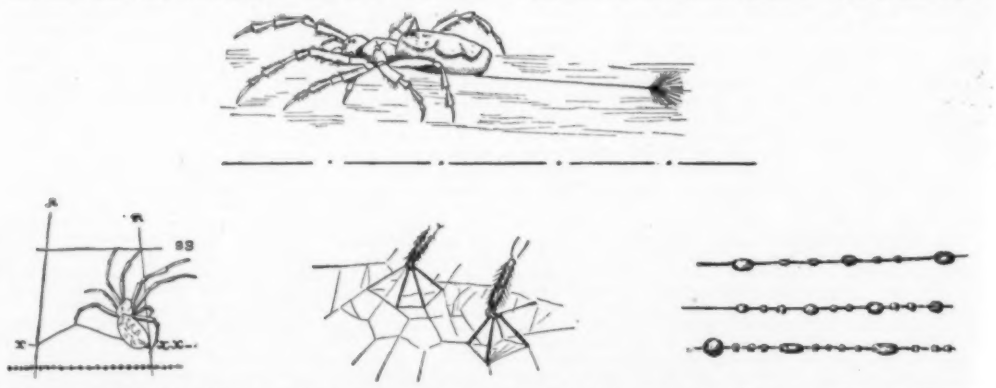


FIG. 6.—MULTIPLE THREADS OF ATTACHMENT; SPIDER LAYING SPIRALS; CLAWS GRASPING AND DRAWING OUT LINES OF THE HUB; VISCID BEADS OF SPIRAL LINE.

* A paper read by Miss Mary I. Cunningham at the Bucks County Natural Science Association's summer meeting, at Buckingham, Pa., June 3, 1899. Revised by the author.

nerets covered by the hundreds of minute spools are opened, the clustered threads stick to the surface and at once harden. Then the spider closes together the spinnerets and the many threads converge into one thread. (Fig. 6.)

If you examine one of the little white dots that mark the point of adhesion with a common handglass, you can easily detect the several threads. These boundary lines may always be distinguished by the thickness of the thread, and sometimes by the color.

Another mode of securing a foundation is by air currents. Webs are often stretched between widely separated places, where from the nature of the surroundings it would seem highly improbable that the spider had crawled carrying the thread. In some cases these lines are thirty or forty feet across roads and even creeks, and while it may not be altogether impossible for the spiders to have first carried the thread free from any entanglement, or even across the water, it seemed highly improbable and led to close observations which have given us the positive assurance that these foundation lines are often laid by the help of air currents. Dr. McCook says he has often observed many lines carried directly from the spider's spinnerets, observed the entanglement, has seen the spider draw the line taut and then cross upon it. The spider seems to attach great importance to these foundation lines, and will use them again and again in the erection of new webs; but if these lines are once destroyed it is usually followed by a change of position. In the evening the hours of greatest activity in web-making occur; and if there is no wind, it is sometimes impossible for the spider to make any web. (Fig. 7.)

To show the order in which an orb web is made after having the prime foundation secured by an air current, suppose the spider at the left to have secured an attachment at *X*, crossed over, strengthening the first line by another as it went, and drawing the line tight, returns to the point, *d*, from which it drops down (paying out its thread as it falls) to the object or point on the ground directly beneath it, where it fastens the thread, and ascends to *O*, where an attachment is made and a new line begun. This is held out in one of the hind feet quite free from the drop line and the ascent

FIG. 7.—PLAN OF FOUNDATION BY AIR CURRENT.

continued. This new line is carried up to *d*, and along the first line to *e*, where an attachment is made and the line drawn tight, completing the triangle in which the spider spins the snare. When a four-sided frame is spun instead of three, the same method is pursued, the line, *e o*, being simply carried further around and down the bush or tree until it forms the lower boundary of a trapezoid. The details vary according to the local situation; but this is the general plan of construction. The next step is to place the radii. This is usually done by dropping down from the top line and fastening the thread to the foundation line below. These radii are not spun in regular order but with a keen appreciation of a perfect balance of the snare. Then when the radii are completed the notched zone is made, laying in the spirals from the center outward. The next step is to prepare for the laying of the spirals. This is done by first laying a spiral scaffolding from the notched zone outward, just the reverse of the direction the spider takes when placing the spirals proper. The rapidity with which the spiral line is spun and the peculiar manner in which the spider uses its legs make it extremely difficult to describe the actual method. (Fig. 6.)

Yet we are all probably familiar with the little kick that seems to fasten the line to each radius. However, this is not exactly the case; as the line is fastened by the pressure of the spinnerets on the radius, and one hind leg is used to determine the point for this attachment. The other holds out the thread, allowing it to be loose between each radius. It soon shrinks to the needed length, but thus the elasticity of the web is preserved.

The other legs are used for locomotion alone. When the spirals are completed, it will be seen that not a particle of the scaffolding remains. The spider bites this off and permits it to drop away, or rolls it up in its jaws. The spiral lines are of a different nature from any other lines used in the web, and are covered by viscid beads that adhere and melt upon the wings and limbs of the insects that strike the web. The value of the web is chiefly due to the viscidity of these beads and the elasticity of the lines. Under the microscope the beads look like pearls strung on a cord, and, indeed, on some webs they may be distinguished by the naked eye. They are semi-transparent or translucent, and occasionally one may be seen of a dark color; but this is only a particle of dust or pollen that has become lightly coated by the viscid gum. (Fig. 6.)

These beads vary in size according to the size of the web and its maker.

(To be continued.)

CAPTURING DEVIL FISH.

"I PRESUME the average civilized citizen will regard me as a somewhat ghoulish individual," said Mr. Verrill, of Yale College, detailing his experiences to the writer, "when they learn that I take delight in this unusual sport. The average man associates the devil fish with all that is horrible and mysterious—there is probably no sea monster that is more dreaded or the object of more superstitious awe. I found that the natives of the Bermuda Islands, where the octopus is unusually numerous, regard this sea creature with particular aversion, especially the negroes. They call him the 'scuttle,' and no animal is more dreaded.

"The first requirement for a devil fishing excursion is a bathing suit. The second is a flat bottomed boat. This is all you need. No bait, no fishline and pole are required. You have to be very careful in rowing your boat about, for the devil fish is a very wary fellow, and vanishes at the least shadow of an approaching foe. You have also to be well posted upon his habits or haunts, or you may paddle noiselessly around all day without even so much as a glimpse of your intended victim. When you finally reach the spot where you think the devil fish may be, the only thing to do is to stop your boat as quietly as you can and await developments. The novice will study the water and the bottom of the sea, but will seldom detect the hiding octopus. He may see many other things, such as beautiful corals and large and brightly colored sea anemone, but not the object of his search, although the slimy monster is there, perhaps quietly taking an afternoon nap, but more likely lying in wait for the unsuspecting crabs or lobsters that are so plentiful in those waters. The bottom of the ocean is of limestone, and there are numerous overhanging rocks and caverns. It is under the shade of these rocks or hidden under these caverns that the devil fish is to be found. If you wait long enough, you are likely to see something move; or if you advance too far, the shadow of your boat may disturb his quiet, and send him slinking from beneath the friendly rock into full view.

"He is not an object of beauty, looking remarkably like a huge spider, and for the moment you are likely to regret that you came on your fishing trip unarmed. He is in reality about four feet across, but the water always magnifies, and he appears much larger. He has two eyes, but if you get within view of these the slimy monster will dart under the rock once more. You therefore slowly creep to the stern of your boat and prepare the attack. Unless you are a good diver and swimmer, and are quick of motion in the water, you had better give up the game at once. If you have full confidence in yourself in these respects, you take your position in the stern of the boat and await the favorable moment. The strictest silence must be maintained until suddenly you spring from the boat and dive into the water, directly at the unsuspecting fish. It is only once in a great while that this attack is successful. Nine times out of ten the octopus sees you coming and gets out of the way. If he catches the slightest glimpse of you, or hears the least noise, all your trouble is in vain. Once in his home, under the rocks, no persuasion can draw him forth again, and the only thing to do is to leave him and seek for other prey.

"Occasionally, however, your dive will be successful. If you come upon the monster from behind, so that his piercing eyes do not get a glimpse of you or your shadow, your chances of catching him are fairly good. But even when you reach the poor devil fish in time, you are by no means sure of landing him. There is only one way of catching him alive, and that is by embracing him from behind with your hands at his throat, as it were. It is useless to try to get him in any other way—your attack is not only unsuccessful, but is likely to be dangerous. The thing you have to avoid is not, according to the popular idea, the eight long, slimy tentacles, which are dangerous only in an octopus of unusual size—though they are uncomfortable and unpleasant always—but the mouth, which is located on the under part of the body, as in the shark. It consists of a sharp beak, which strikingly resembles the beak of a parrot. It is his principal weapon of offensive warfare, and unless you are agile and firm it is likely to be used to ugly effect.

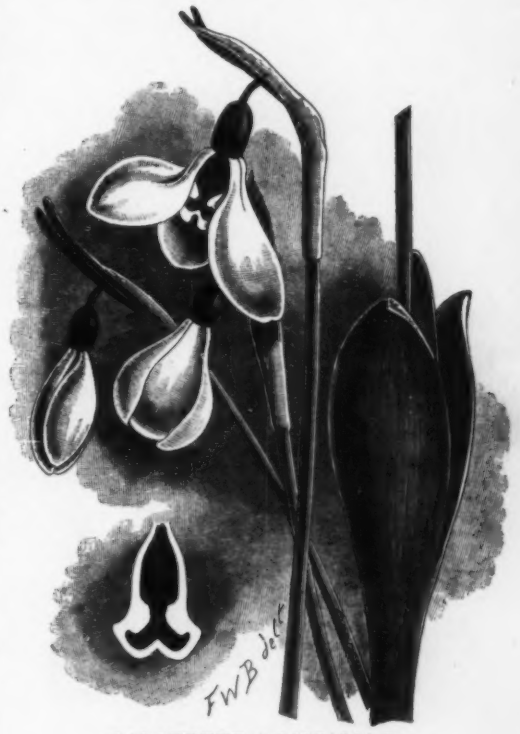
"The first thing the octopus tries to do, after you have laid hold of him by the head, is to get away, and more often than not he succeeds. If you hold him tightly, not only will he fail to escape, but the inky fluid which is one of his defensive properties will find its means of exit choked. His body is soft and slimy like an eel. If, however, he does not succeed in squirming through your hands, he begins to fight. He tries to get his long, slippery antennæ into play, and you feel one of them wind quickly around your arm. It is an unpleasant and gruesome sensation, and occasionally painful. Each tentacle is provided with a large number of suckers, by means of which the octopus seizes its prey. Each one of these suckers, when fastened upon the body, acts as a vacuum cup, and clings firmly by virtue of the pressure of the air outside. The effect is precisely like that of a multitude of cupping-glasses. There is only one way of freeing your arm and the other portions of the body to which the tentacles attach themselves, and that is by taking them at the extremities and peeling them off. It is seldom, however, that they do any great harm. In a few instances they were painful, and for some time after our devil fishing trips in the Bermudas my father's arm was covered with black and blue spots, the result of the cupping process of the tentacles.

"In the main, however, you can afford to ignore this attack. The devil fish only uses it, indeed, for a single purpose. It is not for the sake of sucking your blood, as some imaginative persons would have us believe. The devil fish is no sea vampire; he fights with his beak, like the most respectable animal in the world. His whole aim is to turn on his back so that he can get this weapon of defense at work like the shark. He has wound these antennæ about you for the simple purpose of getting a purchase, so that he can turn himself. Your main efforts, of course, are directed to preventing his getting into such an advantageous position. By the time you are ready to start for the surface you are likely to be somewhat tangled up with the eight tentacles. It is a position not altogether unmingled with horror, but after a few experiences you become hardened to it. What I have described, of course, takes place very quickly, and a few seconds after your attack, if everything has gone well, the whole wriggling mass rises to the surface; the devil fish worming and squirming to get away, winding its tentacles around you and attempting to get its beak in a position to use, and you holding on to the head for dear life in your efforts to reach the surface without losing your game.

"It is the rarest and most exciting sport I have ever known. It is a moment of supreme exhilaration when you reach the surface, jump into the boat, and begin to peel the slimy creature off your limbs. He is still lively and still shows fight. When you finally deposit him in the bottom of the boat, the poor octopus continues his unavailing struggle. He squirms around like a huge spider on his eight tentacles, and in his fury attacks the sides of the boat, upon which he fastens his suckers as tenaciously as to the human arm itself. Only one melancholy fate awaits him. He is taken on shore, packed in alcohol, and sent home to be deposited in the museum. As soon as he gets out of his element he begins to shrink, and turns a dull grayish color. And it so happens that all the devil fish which we brought home and which are now deposited for safe keeping in the Peabody Museum do not do justice to themselves. They are much smaller than when caught in Bailey Bay."—B. J. Hendrick, in New York Evening Post.

GALANTHUS "CASSALIA."

THIS is one of the best and most distinct of all the new snowdrops from Asia Minor, and was sent to us



GALANTHUS "CASSALIA."

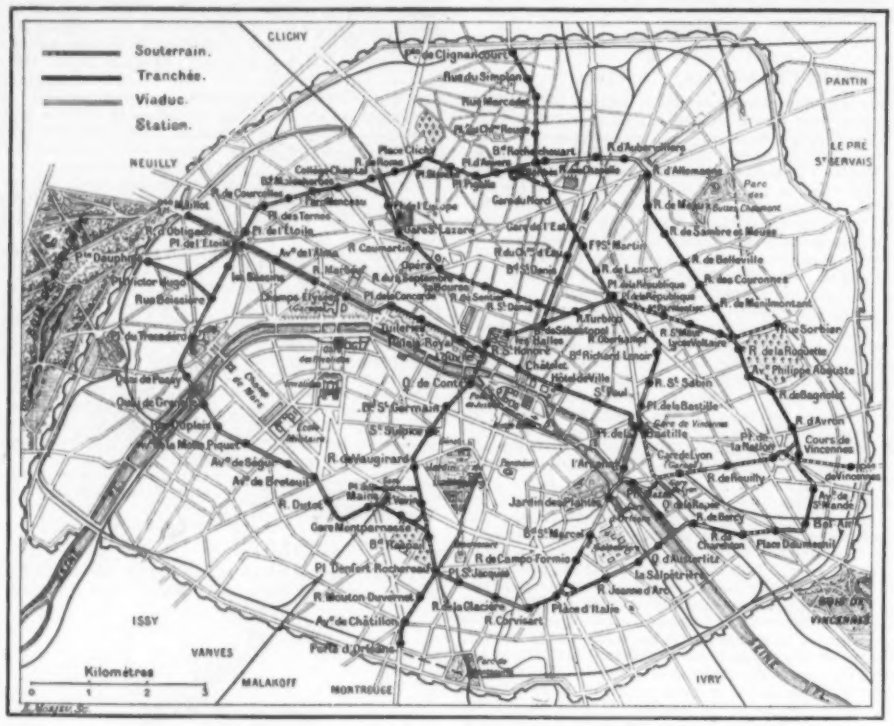
from Smyrna by Mr. Ed. Whittall, says The Gardeners' Chronicle.

G. Cassalia grows a foot high, or more. Its broad foliage is very hoary-looking, being covered with a thick gray bloom, which is easily rubbed off by the fingers. The flowers are large and bold, but quite distinct from those of G. Elwesii in the blotch on the three inner perianth segments. As shown in the sketch, the basal blotch and the two apical dots, or deltæ, are conjoined, and not separate as in the last named kind.

The origin of religion has long been a difficult problem, and is likely to remain obscure for some time yet. The germ, according to Tylor, lies in the belief in spiritual beings; Lippert finds it in the worship of the soul. Herbert Spencer has stated that ancestor worship is the root of every religion, and again that there is strong warrant for the inference that ghost-propitiation is the origin of all religions. C. L. Henning attempts, in The American Anthropologist (vol. xi., p. 373), to solve the question from quite another standpoint. All the investigators in this field, without exception, have neglected one principal factor in their respective researches—the economic conditions. Primitive man had no religion; this was the product of much later times, and did not arise from a so-called "religious sentiment." A system of social virtues, or, in other words, a primitive social morality, was early developed, owing to men being united in hordes; but this has nothing to do with religious perceptions. A man who during his life ameliorated the economic conditions of his tribal companions was not forgotten after his death; of this there are innumerable past and present examples. Such men after their death became heroes or benefactors of their respective tribes. The veneration they enjoyed during life changed after their death into ancestor worship, and later on into soul worship; the two latter forms of worship are the beginning of the historical evolution of religion.

THE METROPOLITAN UNDERGROUND RAILWAY OF PARIS.

AT the time of the Exposition in 1889 the Metropolitan Railway was talked of, the need of it was felt, and the people wished to have it built as soon as possible.



MAP OF THE PARIS METROPOLITAN RAILWAY.

M. Yves Guyot took the project seriously in hand, studied it, and was on the point of pushing it through when the ministry fell.

Since then, the question has not ceased to be one of the absorbing topics of the day. The state and city could not agree on the plans, and the project seemed likely to remain forever in an eternal statu quo; when one day the Chamber, in a moment of good humor, on the day of a crisis in all probability, decided to give in to the judgment of the city, and ratified its project.

One condition of success of the Metropolitan seemed to be the connection of its lines with the railroad stations of Paris. Such connection would offer great advantages, as it would permit travelers to cross the city without going out of the stations, and would thus effect a great saving of time. The greatest advantage was doubtless the possibility of going from any point in the city to the different stations of the suburbs without changing cars. This argument should have caused the municipal council to decide upon a junction, but it had the opposite effect. The council feared that if the Parisians had such inducements for living in the suburbs, the population would decrease, and their octroi would diminish. It also feared that the railroad companies would some day have too decisive a voice regarding the Metropolitan, and would thus become the managers after having been evicted as proprietors. After having decided upon a track one meter in width, which would have altogether put an end to the project, it revised its decision and substituted the normal width, but with this restriction, namely, that the cars should be smaller than those of the companies, and that the rails should be so laid that the cars of the Metropolitan could circulate only on the city system. In this way the city will always be master of the line, and the companies, if they intend to connect with the city line, will have to make their timetables according to its wishes. This condition may become illusionary, however, for when the state gave the concession to the city, it reserved the right of letting the railroad companies make connections with each other in Paris, if they found it convenient. We know that the Company of the East proposes to prolong its tracks to the station at Vincennes, which belongs equally to it, and we already see the Orleans road and the Railway of the West connecting on the quay of the left bank, so that Paris, which has asked for its Metropolitan for so many years without being able to obtain it, is now on the eve of having both.

The lines which compose the Paris Metropolitan are nine in number. Only six of these lines have been approved and are now under construction, while the other three are yet to be built and cannot possibly be begun before 1910.

Following is a list of the lines in the order of construction: 1. From the Porte de Vincennes to the Porte Dauphine, with a connection to the Porte Maillot. 2. Circular line starting from L'Etoile and following the outside boulevards. 3. Ménilmontant to the Porte Maillot. It separates from the two preceding lines at the Rue de Constantinople and passes through the Rue de Rome, the Boulevard Haussmann, the Rues Auber, Quatre Septembre, Réaumur, Turbigo, and Temple. 4. From the Porte d'Orleans to the Porte Cligancourt. This is the north-south transverse line. 5. Boulevard de Strasbourg to Pont d'Austerlitz. It connects the Place de la Bastille to the circular line. 6. Boulevard de Vincennes to Place de l'Italia. 7. From the Place Valhubert to the Quay de Conti. 8. Palais Royal to the Place de la Danube by the Rue Lafayette. 9. From l'Opéra to Auteuil by the Place de la Concorde and the Invalides.

All the lines comprise two systems, a number of transverse lines and a circular line, with other short lines connecting them together at various points.

The total length of the first six lines is about sixty miles, forty of which are underground, ten in cuttings, and ten on viaducts. The power will be supplied from three stations at Vaugirard, Charonne, and Montmartre, and it is estimated that 5,400 horse power will be required for traction purposes alone; but considerably more power will be needed to light the tunnels and stations and run the elevators, etc., so that in all probability as much as 22,000 horse power will be required.

It is now certain that the Metropolitan will not be completed in time for the opening of the Exposition next year. At the earliest, trains cannot be run on it before the latter part of next June, at least two and a half months after the beginning of the great Exposition which is to usher in the twentieth century.

The part now actually in course of construction consists of one complete line and the beginning of two other lines. The first is the main transverse east-west line, which connects the Bois de Boulogne with the Bois de Vincennes. It passes under the avenues of the Grande-Armée and the Champs Elysées, follows the Rue de Rivoli and the Boulevard Diderot, and runs parallel with the Vincennes road till it reaches the gate of the same name. Of the other two lines in course of construction, the most important is that running from Place de l'Etoile to the Trocadero. This has a junction with the first-mentioned line, so that passengers from the Bastille and Rue de Rivoli can take the train directly for the Trocadero. The third line starts at the Porte Dauphine, and runs under Avenues Bugeaud and Victor Hugo to Place l'Etoile. It is the beginning of the great circular railway.

As may be seen from this enumeration, the Place de l'Etoile is to be a sort of central station. (See map.)

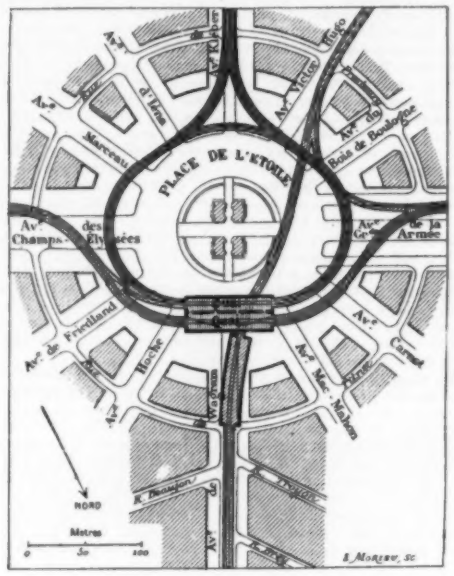


FIG. 1.—MAP OF THE LINES AT THE PLACE DE L'ETOILE.

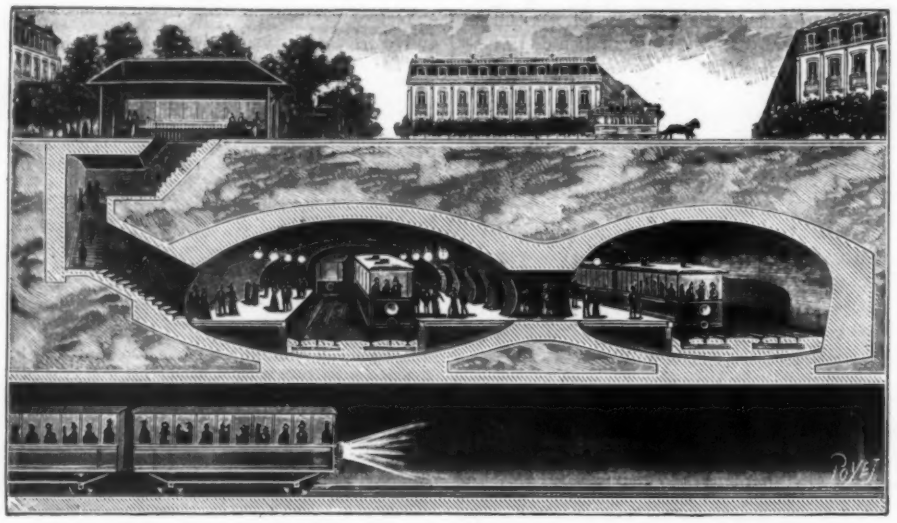


FIG. 2.—THE CONNECTING STATION OF THE ETOILE, PORTE DAUPHINE, AND AVENUE WAGRAM LINES.

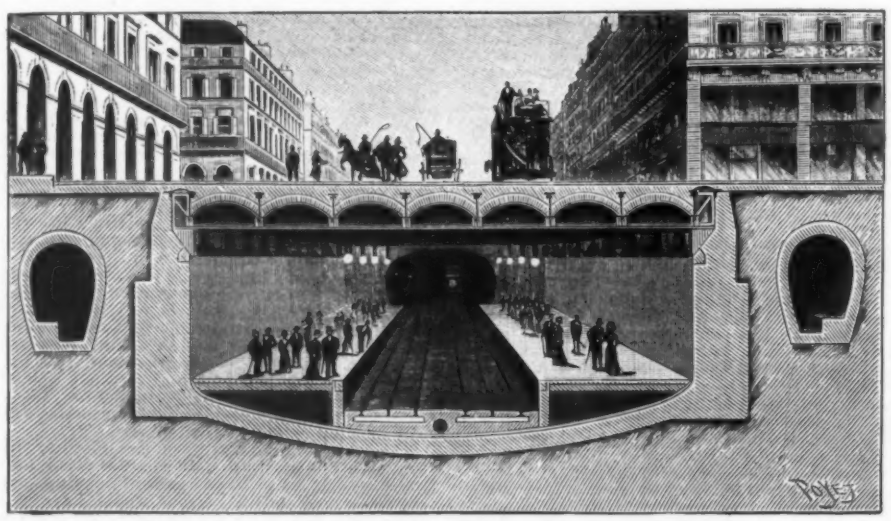


FIG. 3.—THE STATION AT THE PLACE DU PALAIS ROYAL.

Under its roadway the tracks branch out in all directions, making it a little complicated, perhaps, for the reader to understand.

We will describe L'Etoile-Trocadero line first, as it will be the chief of L'Etoile lines. Its track will circle around the Place de l'Etoile, so that the trains coming in will round the curve and return by a descending line of track, without any switching. This is an excellent arrangement, as it facilitates the movement of trains and reduces quite considerably the time of stopping at the terminus.

The Porte Maillot-Champs Elysées line traverses Place de l'Etoile and touches tangentially the curve of the preceding line at a point near the Avenue Wagram. At this point a double station connecting the two lines will be erected. (See Fig. 2.)

The third line, called the Porte Dauphine-Avenue Wagram line, passes under the other two, and its rail is 46 feet below the surface of the ground. There can be no junction of this line with the Porte Maillot-Champs Elysées line because of this fact, but the stations are to be built in the same vertical plane, so that passengers can transfer without going to the surface.

The city is constructing the infrastructure of the Metropolitan, and the superstructure and the operation is to be given over to a special company called the "Société du Metropolitain."

The principal line has been divided into eleven portions; and with the two branch lines which adjoin it, there are now thirteen parts under construction. They are all being built by contractors, with the exception of the first (from the Porte de Vincennes to the Rue de Reuilly), which the city government is building.

It has been found to be quite a difficult undertaking to complete such a large work in so short a time, and it will require all the energy and efforts of the engineers to construct in crowded Paris, without interfering with traffic, an underground railway in the short space of eighteen months.

The method of excavating is very simple. The contractors dig pits at intervals through which the earth is raised to the surface as the tunnel is excavated. They have made as many of these pits as possible, in order to increase the number of working places, and thus decrease the length of time required to complete the work. Some contractors are using hydraulic shields, which, notwithstanding their high cost of $24,000, are found to be economical in the long run. By their use the amount of woodwork necessary to hold up the beams of the galleries is considerably reduced.

The shield sometimes takes in the whole cross-section of the tunnel, which is then constructed at a single operation, in successive rings. At other times, only the arched roof is cut out with the shield, after which it is necessary to excavate the tunnel down to the level of the roadbed. Whichever way it is used, the rôle of the shield is not to pierce the earth, but to sustain the roof for the time being. The workmen are placed in front of the shield, where they work with pick and shovel, preparing the way for it. When this has been done the hydraulic rams, which bear against the woodwork of the tunnel, are operated and the shield forced forward, so that the earth is held up by its metallic ceiling. The hole behind it is immediately bricked up and the center is not taken out for five or six days, in order to give the masonry time to set properly. There are eight or ten metallic rings behind the shield, and each time the latter is moved forward, the last of these is unbolted and carried forward, where it is placed in position as a center upon which to construct the new section of brickwork.

Unfortunately the shield cannot always be used, and there are places where recourse cannot be had to it, as, for instance, in the curved sections. At several points on the line the contractors have not been able to secure one in time, and, as they must not lose a day at any cost, they have set to work by the ordinary process.

In this case, they employ the means generally used in the construction of tunnels, that is to say, they make an advance gallery which is quickly timbered over, and is not extended forward till it has been completely finished.

The contractor who is building section 9 under the Avenue Kléber has devised an altogether new and bold method of construction, which has given the best results and which permits of carrying on the work very rapidly.

He begins by digging an advance tunnel about 6 feet high which has its bottom at the same level as the floor of the completed tunnel; then he constructs a second arch-shaped gallery above the first and separated from it by a layer of earth 4 feet thick, and bricks in the arch, using the layer of earth between the two galleries as a center. Holes every 38 feet connect the upper arch-shaped excavation with the lower tunnel, which simply serves as a convenient passage through which to remove the earth rapidly. Arch buttresses are built on both sides in trenches sunk from the surface, and the roof rests on them. After the masonry is completed, the earth is removed very quickly through the smaller tunnel, until the whole space inside is cleared away.

The work is progressing very rapidly, and an advance of 12 feet per day is regularly made.

No serious trouble has been experienced with the ground caving in, as the subsoil of Paris is composed of calcareous clays, crystallized carbonates, and loam. Sometimes the workmen strike the remains of old buildings such as the Tower of Liberty. A great deal of rubbish is also found buried in the earth.

The Metropolitan has upset the sewer system in the streets which it traverses, notably in the Rue de Rivoli, where two smaller side sewers have been substituted for the large central one.

There are two types of stations. Whenever the tunnel is far enough below the surface, the stations are bricked up, as in the Place de la Nation; but in certain places, as at the Palais-Royal and the Hotel de Ville, water was encountered, and this made it necessary to bring the tunnel as near to the surface as possible.

Piers were built in trenches on each side of the roadway; then the latter was excavated just deep enough to lay the cross-girders and roof, and after this had been done the roadway was immediately filled in and opened again to traffic. Then the earth was removed from inside and the station completed. The station at the Place de la Bastille is in the open air, and is a very interesting piece of work because of the proximity of the canal St. Martin.

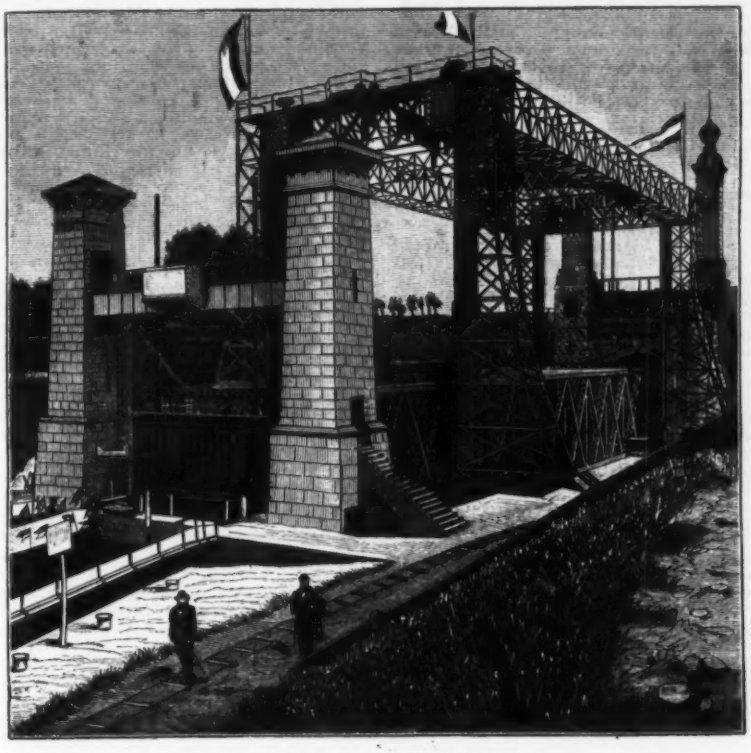
One difficulty that was encountered at first was the removal of the earth. In excavating around the Arc de Triomphe, the contractors made use of the tramway on the Avenue de la Grande Armée and carried the earth away to the suburbs. At certain points, as at the Place de la Concorde, lateral tunnels running to the Seine were constructed, and the earth was taken through them and dumped into boats. When no other way could be found, horses and carts had to be resorted to, but these were found to be troublesome, costly, and slow.

No special arrangements have been made for ventilation, as it is thought the stations, which will be less than half a mile apart, will maintain a constant draft, and as, moreover, the air will not be vitiated as on steam roads. The cars are to be propelled by electricity, so there will be no smoke and scarcely any deleterious gases to be dealt with. The tunnels are to be lighted by electricity their entire length.—La Nature.

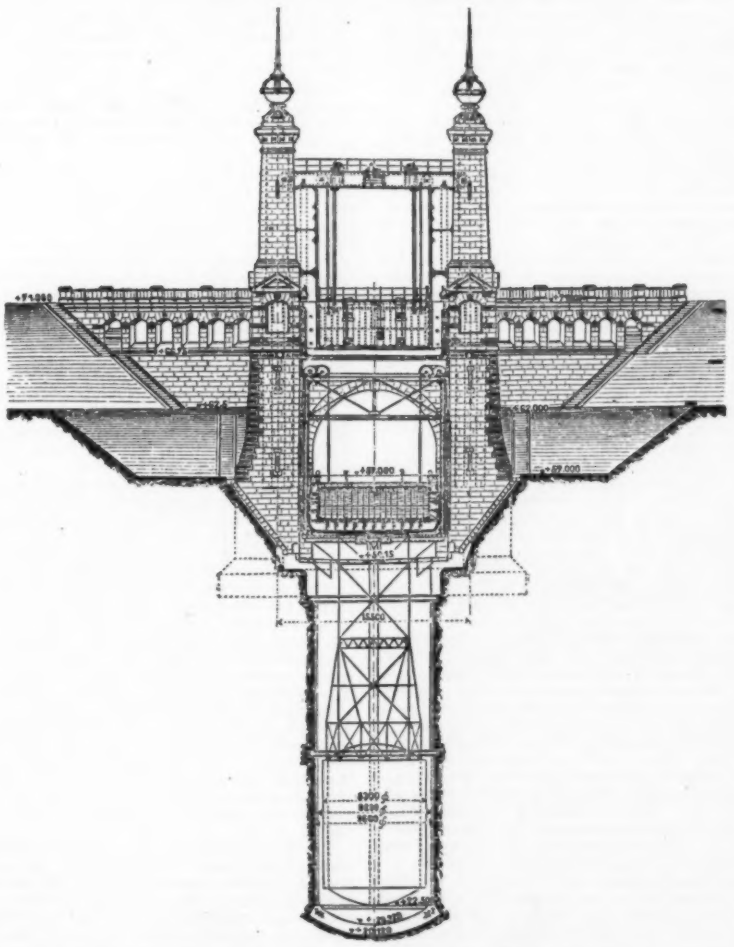
THE GREAT CANAL LOCK AT HENRICHENBURG.

THE most important structure in the Dortmund-Ems Canal, from a technical point of view, is the enormous lock at Henrichenburg, and therefore, although we published an illustration of this lock in our SUPPLEMENT for June 25, 1898, we take pleasure in again calling the attention of our readers to the subject.

The Henrichenburg lock, which lies at the juncture of the Herne-Munster and Dortmund Canals, is capable of receiving ships having a length of 213 feet, beam of 26 feet, and depth of 6 feet 6 inches, and a capacity of 600 tons, and raising them from the lower to the higher level, a distance of 46 feet to 52 feet, in a single vertical lift. The load to be lifted is about the same in all cases, regardless of the size of the vessel, for the latter displaces and forces out into the canal a mass of water corresponding to its own weight. This total load, consisting of the ship, the water in the lock chamber, and the iron of the structure, is always about



THE LOCK AT HENRICHENBURG.



CROSS SECTION OF THE LOCK AT HENRICHENBURG.

3,000 tons and is carried, through the medium of the high framework, by five immense floats immersed in deep wells, and as they have a constant buoyancy of 3,000 tons, the load is always counterbalanced. These floats are hollow iron rollers 27 feet in diameter and are filled with atmospheric air. No lock was ever before constructed which would carry so heavy a load. Few realize that the load per square foot carried by such a structure is far greater than the load per running foot of the heaviest railroad bridge, and that the lock is subject to such tremendous distorting strains that only the simplest mechanism can be employed, as anything of a complicated nature would always be out of order, so that traffic on the canal would suffer great delays. The constructors of the Henrichenburg Canal, Messrs. Haniel and Lueg, of Düsseldorf, are certainly to be congratulated on the success of their undertaking. We are indebted for the accompanying engravings to our worthy contemporary, Der Stein der Weisen.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Peruvian Trade and the United States Tariff.—Minister Dudley sends from Lima, May 4, 1899, translation of a recent editorial from El Comercio, as follows:

"According to latest telegrams, copper is quoted in London at £77 ($374.72) per ton; silver, at 28⅛d. (57·78 cents) per troy ounce; and granulated Peruvian sugar at 13s. ($3.406) per cwt. These quotations relating to three principal export products of Peru are very flattering and significant, since the rise which all have experienced indicates greater gain and benefit for the commerce and industry of the nation.

"The upward movement in the price of copper, which began several months ago, is attributed principally to the great consumption occasioned by the more general employment of electricity and the new discoveries in that branch; also the fact that it has been demonstrated to be indispensable to cover the keels of men-of-war with a shield of copper, in order to avoid loss of speed in consequence of the great quantity of mollusks which attach themselves in a few weeks to iron bottoms. This precaution, as is easily understood, necessitates the use of immense quantities of copper.

"It being possible, according to the interesting report concerning Cerro de Pasco, recently published by the National Society of Mines, to estimate the exportation of minerals, etc., connected with our new copper industry at about 1,000 tons per month, the increase in price represents at least a couple of million soles more annually in the total value of those exportations.

"The increase in the price of silver is a subject still more interesting to the country. To judge by notices which appear in certain European periodicals, it appears that the great producers of silver in the western part of the United States, in agreement with the owners of the principal smelting establishments, have formed a league for the purpose of exercising a certain control over the price of silver and of making New York the principal market for the purchase and sale of that metal, a prerogative which thus far, and for more than a century past, has been quietly enjoyed by London. To this league is attributed the intention of raising the price of silver about 15 per cent.—that is, to advance it from 27⅛d. to 32d. (55·75 to 64·84 cents). At this price, the intrinsic value in gold of our silver sol would be 24d. (48·66 cents), which would fortify in a most satisfactory manner our present monetary standard, at the same time causing the injury to disappear which is now suffered in effecting sales of silver bullion, in consequence of the difference between its metallic and its monetary value.

"But undoubtedly that which is the most worthy of study is the new destination given during recent months to the shipment of sugar. There has been put into effect in the United States the tariff which establishes an additional duty exclusively on sugars from those countries which give a bounty (prima) upon exportation; a duty which, in consequence of being always equal in amount to the bounty paid, the English call countervailing (compensating) and might be called "para-primas," since, in the same manner that the "para-rayos" (lightning rods) protect us against lightning, those duties protect us against the bounties. The proceeding mentioned has produced the result which was to have been expected, and, in fact, has closed the doors to the importation of beet sugar into the United States,* because the importers of sugar from Germany, France, and Austria, being obliged to return the bounty which they had received in the form of an additional duty, have ceased to ship to the American market, and it has fallen to cane sugar, on which there is no additional duty, to supply the demand.

"This in itself satisfactorily explains the change in the direction of our exportations; but there is something more. The reduced shipments made during the last year to the United States have permitted the refiners of that country to appreciate the quality of our sugar; and, convinced in a practical way of its superiority, they pay higher prices for the Peruvian product than for that of any other origin. In view of the fact that our sugar brings 1s. (24 cents) more in New York than in Liverpool, it cannot surprise us that almost all produced within the last few months has been consigned to the first of these ports, nor that the greater part of that which will be produced up to next June has been purchased for shipment to the same place.

"We thus see that by reason of the causes indicated, there has been opened for our sugars the principal market of the world, which for itself alone consumes the fabulous quantity of 2,200,000 tons per year; and that the New York market has been substituted for the old one of Liverpool.

"The influence which this change must exercise in our foreign commerce must be great, and will certainly facilitate the exchange of some of our other products for the manufactures of the United States.

"This is a natural evolution, the proper result of the geographical situation of both countries and the general development of the commercial and political interests of the American republics; and the complete realization of this idea will be promoted by the efforts of the statesmen, the wealth of the capitalists, and the energy of the promoters of the great republic of the North.

"The construction of the canal to unite the Atlantic and the Pacific, a work which it is no longer possible to consider doubtful; the establishment of a great international bank with branches in all the capitals of the American republics, a project which has received the approval of one branch of the United States Congress*—will give a great impulse to commercial traffic among all the nations of this hemisphere. But that which will undoubtedly be conducive to the greatest development of pan-American commerce will be the construction of the central railroad which, traversing the three Americas from north to south, will, in the end, unite New York and Buenos Ayres.

"The greatness of this work predisposes one to consider it Utopian; but when one considers that of the 10,228 miles which separate the northern from the southern metropolis, 4,762 are constructed and the execution of the remaining 5,456 only requires the expenditure of $174,000,000, of which more than $100,000,000 would be spent within the United States itself in the purchase of rails, rolling material, bridges, etc., it ceases to appear so difficult to realize a work which already has its principal branches, as would be the lines from Oroya to Callao, from Puno to Mollendo, from Oruro to Antofagasta, and from Rosario to Mendoza, and also from Santiago to Valparaiso, not to mention the Mexican railroad.

"But a few years ago, still more difficult appeared the realization of the construction of a railroad across the continent of Africa, beginning at Cairo and ending at Cape Town; nevertheless, to-day it is no longer a matter of doubt that within a relatively short time that road will be in operation. The existence of the great railroad of our continent, destined to bind together all the Latin-American republics, would constitute their principal element of prosperity and stability, and, at the same time, would make New York the commercial and financial center of the whole of this extensive and rich hemisphere. Its power and preponderance would be so advanced that in the next century we would see New York disputing with London the predominance which it has maintained in the business world, and especially in financial matters, during the century about to close."

Electric Traction in Marseilles.—Several inquiries have recently been sent to the consulate at Marseilles, says U. S. Consul Robert P. Skinner, concerning passenger transit, concessions, rates of fare, and possibilities open to investors. In reply to these, and for the benefit of the public, it may be said that shortly before the writer took charge of this post a convention was concluded between the city and the Compagnie Générale Française de Tramways, of Paris, whereby the latter secured a concession for the principal streets of the municipality. The concessionnaires are now revolutionizing the traction system of the city, and in the course of the year, electric motors will be in operation on every important thoroughfare.

Until the present time, Marseilles has had an inadequate service of horse cars and omnibuses. Under the new order of things, many of the omnibus lines will continue, for a time at least, but the horse cars will be retired. The concession will expire on December 31, 1950, and, as required by French practice, it has been ratified by both the city and the State. The system of traction is known here as the Dickinson overhead trolley. The company is obliged to replace in perfect order, and to pave when necessary, the surface of the streets disturbed between tracks, including the space between double tracks, and an additional strip 35 centimeters (14 inches) wide along each outside rail.

At the present time, the fares on various lines are regulated by distance. In the heart of the city, the usual fare is 10 centimes (2 cents), and for longer rides as much as 40 centimes. When the electric lines are installed, the uniform fare of 10 centimes only will be charged. To the city, the company will pay an annual fee of 100,000 francs ($19,300) for the use of the streets, and when the gross receipts for a year aggregate 7,000,000 francs, a supplementary fee will be paid as follows: For the eighth million, 40,000 francs ($7,720); for the ninth million, 50,000 francs ($9,650); for the tenth million, 60,000 francs ($11,580); and for every million over ten, 60,000 francs.

Electric trains will not be composed of more than four cars. The length of the train must not be over 36 meters (118 feet) and the speed must not exceed 20 kilometers (12·42 miles) per hour.

Upon the expiration of the concession, the State will become the owner of the tracks and appurtenances, and all other property of the concessionnaires located on the public domain; and during the last five years of the concession, should it appear that the operating company fails to maintain the property in good condition, the State reserves the right to seize all the company's revenues for the purpose of keeping up the same. The State will have the right to take all rolling stock, tools and similar movable property at a valuation fixed by experts, but will be under no obligation to buy more than suits its purposes or wishes. Upon the termination of the concession, should the State deem it useless to continue the operation of certain lines, the concessionnaires will be required to remove their tracks and restore the streets to their original condition.

The State reserves the right to purchase its concession at any time. The price, in such event, will be fixed by the net annual revenue of the seven preceding years, including the fees paid to the city. From the total thus obtained will be deducted the net revenue of the two least profitable years, and the average of the five remaining years will stand as the amount of an annuity, to be paid to the concessionnaires during each unexpired year of the revoked concession.

Gold in the Transvaal.—Consul Macrum sends from Pretoria, April 18, 1899, copies of the report of the chamber of mines on the production of gold in the Transvaal for the month of March, 1899.

The following extracts are from the report:

Yesterday saw one of the largest increases over the previous month ever recorded in the Rand's history. An increase of close upon 40,000 ounces is a marvelous achievement. The Transvaal production of the precious metal, when expressed in ounces, is now getting within measurable distance of 500,000, yesterday's declaration being within 36,000 of that aggregate. The March yield is 28,361 ounces better than the declaration of December, 1898—a month which is invariably good. The Rand output itself was 37,240 ounces in advance of the February figure and 22,074 ounces higher than the record of December. Yesterday's output was well nigh double the figure of two years ago; it was, indeed, 115,500 ounces in advance of the showing of March, 1898. We cannot compare these results to those of any other gold fields, for they have no analogue. The Rand stands pre-eminent, singular, and will continue so to stand far in advance of all rivals.

Mr. Macrum adds:

The value of these 464,036 ounces of the precious metal was £1,763,336 ($8,584,666), and the average exports of gold from the ports of South Africa amount now to about £430,000 ($2,092,595) each week.

Omnibus and Tram Service in Paris.—Passenger transit in Paris is effected by electricity, steam, compressed air, and horse power, says United States Consul-General John K. Gowdy. There are three tramway lines serving Paris and the suburbs, and omnibuses are generally used throughout the city.

One of the above mentioned tramlines belongs to the Compagnie Générale des Omnibus, and the other two are practically controlled by the same company; so that it can be said to have a monopoly of the entire passenger transit, exclusive of cabs and carriages. It is a stock company, organized in 1855, having obtained from the city by conventions of July 15, 1856, and June 18, 1860, the exclusive right to transport passengers from one point to another in the city of Paris. This concession expires on the 31st of May, 1910.

The omnibuses are of two sizes and drawn by two and three horses respectively. The smaller model is arranged for 28 to 30 places (14 outside, 14 inside, and 2 on the platform). The larger model affords accommodation for 20 on top and 20 inside, including 4 on platform.

The fare on the top is 15 centimes (nearly 3 cents); inside and on platform, 30 centimes (nearly 6 cents). The payment of the last-mentioned fare entitles the passenger to a "correspondence" or transfer ticket to another connecting or intersecting line. No passengers are taken on when the places are filled, either at a station or en route. At the starting points, numbered tickets are handed to the passengers, and when there are more than enough to fill one conveyance, the precedence is given to those holding the first numbers. The next omnibus or car starting begins with the number last uncalled on the previous vehicle. The same system prevails at the fixed stations en route for vacant places. No standing in the aisle is allowed.

It is impossible to say what the company paid for the concession, as the remuneration to the city is based upon a percentage and a royalty on the number of vehicles working.

The statistics for 1896 show the number of passengers carried as follows:

33 lines of omnibuses (26 to 30 places).	50,030,034
14 lines of omnibuses (40 places).....	79,349,631
3 lines of steam tramways.....	12,862,990
23 lines of horse tramways	87,092,926
4 lines compressed air and electricity.	10,705,340
Total	240,040,291

The distances traversed by the divers lines vary from about 2 miles to a little over 4 miles.

The bonds of the Compagnie Générale des Omnibus de Paris are for 500 francs ($100), 4 per cent. interest, and were quoted on the 4th of May, 1899, at 506 francs. Shares of 500 francs denomination are quoted at 1,690 francs. Dividends on the stock are declared after deducting expenses, including stipulated amounts paid to the city of Paris for the concession.

In 1897, the company employed 16,017 horses, and the maximum number of vehicles working in one day was 1,130.

Banana Trade of Nicaragua.—Under date of May 10, 1899, Consul Sorsby, of San Juan del Norte, writes:

The fruit trust, operating in the West Indies and Central America, the principal associates of which are the Boston Fruit Company, of Boston, Minor C. Keith, of Costa Rica, and others, have entered the banana fields of the Department of Zelaya (Bluefields and Rama districts), Nicaragua. Their representative, Mr. J. Lamotte Morgan, arrived at Bluefields on the 28th ultimo and, going into the heart of the banana district, secured contracts from nearly all of the larger planters. Mr. Morgan tells me that it is the purpose of his people to put on a line of steamers immediately, with the view of controlling all of the banana trade of Nicaragua. The advent of this new corporation will probably have the effect, at least for the present, of advancing the price of bananas and cheapening freights on incoming and outgoing cargoes. Mr. Morgan states that the freight and passenger service of the new line will be in every respect superior to that of the old company, and it is probable that a small but fast steamer will be run as an auxiliary between Port Limon, Costa Rica, and San Juan del Norte, Bluefields, and Cape Gracias, Nicaragua.

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No. 450. June 13.—Waterworks in Russian Cities—Wheat, Flour, and Canned Meats in South Africa—*Windows and Doors in Marseilles—*New Gold Mines in Mexico.

No. 451. June 14.—Railway Construction in Mexico—Irrigation in Mexico—Light Railways in Argentina—Belgian Trade with the United States in 1899.—*Omnibus and Tram Service in Paris—*Gold in the Transvaal.

No. 452. June 15.—Proposed Railway in Peru—*Shoes in China—Commercial Travelers in France and Denmark—Castor Oil Plant in India.

No. 453. June 16.—Railway Contract in Venezuela—Collection of Debts in Japan—The Paris Bourse of Commerce—*Pork Condemned in Sweden—Wheat Imports of Spain—Constructor of the Siberian Railway—*Embroidery School at Plauen.

No. 454. June 17.—State Trade in France—Free Zones in France—*Electric Traction in Marseilles—Mineral Production of British Columbia—*Banana Trade of Nicaragua.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

* Note by Bureau of Foreign Commerce.—The imports of beet sugar into the United States, according to Treasury returns, have been: In 1896 (calendar year), 1,092,389,004 pounds; in 1897, 1,373,220,362 pounds; in 1898, 418,981,230 pounds.

* Note by Bureau of Foreign Commerce.—The bill was discussed, but did not pass either House of Congress.

ENGINEERING NOTES.

In a report on the Consular District of Genoa just issued by the Foreign Office, Mr. Vice Consul Towsey, the British representative at Spezia and Massa-Carrara, refers to the completion of the Messrs. Hofer Manaira & Company's shipbuilding yard, adjoining the leadworks at Pertusola, on the Muggiano shore. It finds employment for nearly 2,000 hands, and has six building slips, all of which have been occupied, the first launch having taken place late in February. This was the "Guiseppe Accame," 325 feet long, 46 feet beam, and with a carrying capacity of about 4,000 tons. She is being fitted with triple-expansion engines and boilers of the multitubular marine type, supplied by Messrs. Thomas Richardson & Sons, of Hartlepool, who with the North-eastern Marine Engineering Company, of Wallsend-on-Tyne, and Messrs. George Clark, of Sunderland, are supplying the engines and boilers of the other ships now in course of construction. British firms are also supplying pumps, elevators, chains, cables, anchors, etc., while most of the machinery in the dockyard itself is of English make, Germany and Italy supplying the remainder.

"It has often been suggested that the building of railroads through the Philippines would greatly facilitate their development," says Samuel B. Belford in The Review of Reviews. "As applied to Luzon alone the suggestion is true. If a railroad should be built from the north and south of Luzon into and from Manila, it would double the population of that city and increase its export trade to a paying extent. It would have a still greater influence in the pacification and civilization of the people. They would become familiarized with one another and with ourselves. It would accustom them to the spread of modern ideas and result in a more general diffusion of knowledge. Spheres of foreign influence in China are scarcely more than lines of railroad building and proposed. The people of the Philippines are divided into tribes knowing little of one another and usually living in a state of armed neutrality. Under the Spanish régime the northern islanders were sent to southern garrisons, while the southern tribes were pressed into service in the north. The immediate effect of a transinsular railroad would be to lessen the feeling of tribal hostility and avoid the ever-present danger of internal warfare. The other islands are too small for the introduction of railroads."

As one of the points to which a large portion of London's traffic converges, the space in front of the Mansion House has long been a source of wonderment to those acquainted only with quieter streets and thoroughfares. It possesses another feature of interest, for the roadway, which was formerly a solid piece of work, is now supported on steel girders, or propped up on balks of timber and brick walls. In a few days what remains of the latter will be knocked away and steel beams substituted. On these concrete is to be laid with asphalt above, and then the traffic will go over a series of tunnels that constitute another engineering triumph of the century. The work has been done in nearly a dozen sections, and, although only one has yet to be completed, it is hardly likely that the entire work will have been got ready for the public service before the end of the year. Then there will be a well lighted subway running round the busy space between the Bank and the Mansion House, access to which will be had from the street corners, while the South London Electric Railway and that between Waterloo and the City will have direct communication by means of slopes. Thus the fears of nervous wayfarers will be overcome and London placed under another obligation to the engineer.—Industries and Iron.

Manganese Steel for Burglar Proof Safes.—The discovery of manganese steel is due to Mr. R. A. Hadfield, the present head of the famous Hecla Works in Sheffield, England.

The discovery of a metal of such extraordinary properties, combining as it does the highest tensile strength with absolutely unapproached elongation, started steel metallurgists all over the world experimenting to see if they could discover some steel or alloy having even higher physical properties. This search has resulted in the discovery of some valuable steels, notably those produced through the addition of molybdenum and vanadium, but nothing equaling manganese steel in the combined properties of hardness and toughness has been produced.

It was long ago proposed that manganese steel would make a good burglar proof safe, but as the material was too hard to be machined, no way was devised to apply it for the purpose.

This difficulty, it is stated, has at length been overcome. Experiments with guncotton and dynamite on manganese steel plates are said to have demonstrated that the resistance of this metal to the action of explosives is unequaled by that of any metal at present known.

A New Process for Case-Hardening Ingots.—The Demenge process of hardening steel ingots, which is in use at one of the principal steel works of France, consists in directly carburizing one of the faces of the ingot, at the time of casting, by lining one of the vertical sides of the mould with carburizing substances. The carburizing action is prevented from penetrating too deeply into the inside of the ingot by casting the vertical side opposite to the carburizing side. The carburization of the one face by this method is said to be quite uniform.

The case-hardened surface is rather rough; but all irregularity disappears in forging, which may be effected without special precaution and at a comparatively low temperature, by the press rather than the steam hammer. Ingots of ½ to 3 tons have been cast in this manner; and a 3-ton ingot, 16 inches thick, reduced by forging and rolling to one-fourth that thickness, was found to contain 1·78 to 1·5 per cent. of carbon between its hard surface and a depth $\frac{1}{16}$ inch; from 0·60 to 0·40 per cent. between 1 and 2 inches from the surface, and from 0·35 to 0·15 per cent. between $3\frac{3}{16}$ and 4 inches.

This method appears to be capable of accomplishing substantially the same results as those attained by the so-called "Harveyizing," but more simply.—Journal of the Franklin Institute.

MISCELLANEOUS NOTES.

Mr. Charles A. Witchell discusses bird language in Knowledge. Malice and love are not, it would appear, readily distinguishable by the tones of bird song. While the blackbird, starling, chaffinch, and others may be pouring out the truest love-notes, the robin, thrush, and hedge-sparrow, though also singing, may be using the very "Billingsgate" of birds. "If a singing robin be watched, especially in autumn, he will be seen to attack any other singing robin which may be near; yet the birds will be singing all the while, and their songs will be like the ordinary songs of the species, though a trifle sharper in tone. The music is evidently intended to convey the animosity of the birds."

An American manufacturing company has just acquired an extensive piece of land and a plant at Coventry, including some of the properties once in possession of the tire companies directed by Ernest Terah Hooley, which will be fitted to meet modern requirements in every respect. The capital is said to be $500,000, and the company, it is added, means to rush the construction of automobiles, which has been almost neglected in England, and it is believed that with the great superiority of American cars, coupled with labor-saving machinery, the company will get a clear six months' start in the market over its English rivals. The new departure has already created anxiety, and some of the biggest cycle firms are contemplating similar ventures.

Physiologists have often discussed the question of the relative rise of temperature in the human body produced by mental and physical exertion. Doctors Pembery and Nicol have shown in The Journal of Physiology that mental work has little or no effect on the deep-seated temperature of the body. Mental work involves muscular rest, and this in turn causes a fall in temperature more than enough to mask any rise due to activity of the higher portion of the nervous system. The authors further show that the common test of temperature of the mouth is not an exact measure of the temperature of the body. It is always unreliable after exercise or in cold weather, owing to the cooling of the mouth. Altogether, mental work has little influence, and rest and sleep are the most potent factors in producing the fall in temperature when the body is inactive.

A London parish, says The Hospital, has put forth a well-intentioned paper on the precautions which should be taken by the public in order to diminish the diffusion of tuberculosis; and has given therein an account of the tubercle bacillus which is distinctly funny. . . . Readers are gravely informed that the bacillus in question is so minute that many millions of them could stand on the point of a common sewing needle. This appears to be a plagiarism from the Mohammedan account of certain angels; and it would be better to adopt a more common and certainly more truthful way of assisting persons who are not familiar with microscopic objects to form some approximate notion of the size and shape of a bacillus. This may be done by saying that one million individuals, arranged in a thousand rows of a thousand each, could be placed upon a penny postage stamp.

The "Biokam," an instrument for amateurs interested in the production of living pictures, strikes us, says Knowledge, as being eminently adapted for bottling up, so to speak, those animated scenes, incidents, and phenomena when for reasons general or special their reproduction may serve some useful purpose. The "Biokam" is so compact, portable, moderate in price, and easy of manipulation that it bids fair to attain the same degree of popularity as the ordinary camera. Indeed, the film, twenty-five feet in length and containing as many as seven hundred pictures, can be wound on a sort of creel and developed as easily as an ordinary plate The exposure, by means of a train of wheels, can be effected at such a speed that each separate impression is practically instantaneous, and thus an unlimited number of midget portraits or photographs of scenery may be taken with a minimum of trouble. The instrument is provided with two lenses —one for negatives, the other for projection purposes— by which means living pictures taken by the amateur himself may be thrown upon the screen for his own delectation and that of his friends.

MM. Marmier and Abraham have studied the methods of rendering drinking water bacteriologically pure, with a view to supplying such pure water to towns on an industrial scale. The municipal authorities of Lille authorized them to install an apparatus for the production of ozone, in order to find out by experiment what was the value of that substance when applied to the purification of water by means of apparatus and methods specially devised for the purpose. Experiments made from December 10, 1898, to February 12, 1899, have already led to certain conclusions, which are set forth by A. Calmette, one of the experts appointed on the water commission by the town of Lille. The efficacy of the ozonizing apparatus is unquestionable, and the method is superior to all others that have been tried, and is suitable for dealing with large quantities of water. The apparatus itself is sufficiently strong and its output is regular enough to justify its use in industrial operations. All the pathogenic or saprophytic microbes met with in the waters under experiment were destroyed by passing the waters through the ozonizing apparatus. A few of the Bacillus subtilis alone survived the ordeal. Only one of these germs was found capable of remaining in 15 c. c. of water that had been treated with ozone in the proportion of 6 milligrammes per liter of air. A concentration of 9 milligrammes per liter reduces the number to 1 in every 25 c. c. of water so treated. It is important to note, however, that the B. subtilis is harmless to man and to animals, hence the weaker concentration of ozone is sufficient for the purpose. The water, moreover, is weaker in organic matter than ordinary drinking water, and is less prone to ulterior pollution, and is more agreeable to the palate by reason of the process of aeration which it undergoes. The water commission has recommended the adoption of the process by the authorities of Lille.—Annales de l'Inst. Pasteur, 13, 344.

SELECTED FORMULÆ.

Ice Creams.—

VANILLA ICE CREAM.

1. Milk	1	gallon.
Sugar	4	pounds.
Eggs	4	
Rich cream	6	quarts.
Vanilla extract	½	ounce.

Bring the milk to boiling, add the sugar, stirring all the time, and then set aside to cool. Beat thoroughly the whites and yolks of the eggs separately, add the cream and the flavor, mix with the sweetened milk, and freeze as usual.

2. Cream	2	gallons.
Milk	2	quarts.
Condensed milk	1	pint.
Sugar	4	pounds.
Gelatin	1	ounce.
Flavoring, as desired.		

Soak the gelatin in water for two or three hours, dissolve in the milk by aid of heat, add the other ingredients, stir well, and freeze.

3. Milk	2	gallons.
Sugar	4	pounds.
Flour	4	ounces.
Eggs	12	
Common salt	1	drachm.
Flavoring, as desired.		

Mix the flour, sugar, and salt with one quart of the milk, add the eggs, which should be well beaten, and the flavoring; heat the milk to boiling, mix all together, boil for a few minutes, let cool, strain and freeze.

CHOCOLATE ICE CREAM.

Chocolate may be used with any of the preceding in the proportion of four to eight ounces to a gallon of cream. The chocolate is dissolved in a separate portion of milk or cream and added to the other ingredients.

PURE ICE CREAM.

Pure cream	2	gallons.
Sugar	2	pounds.
Flavoring, as desired.		

Mix well and freeze.

CHEAP ICE CREAM.

Pure milk	2	gallons.
Sugar	2	pounds.
Corn starch	¾	pound.
Flavoring, as desired.		

Dissolve the starch in a quart of the milk by the aid of heat, mix all together, continue to heat until slightly thickened; then flavor and freeze.

CUSTARD ICE CREAM.

Fresh milk	2	gallons.
Granulated sugar	2	pounds.
Eggs	36	
Flavoring, as desired.		

Beat the eggs thoroughly, and add the sugar, stir ring up well together; put the milk on the fire and stir all the time until it boils; pour the milk into the sugar and egg mixture, stirring all the time; set on the fire and stir for a few moments until slightly thickened. Strain and cool, flavor and freeze.—Druggists' Circular.

Processes to Clean Marble.—We have recently received, says The National Druggist, a number of queries regarding the cleaning of soda fountain marbles. To save labor we have collated the following, which embrace all of the more practical methods. We would remark that if the marble is merely worn and not stained, acids should not be used.

1. Wash the surface with a mixture of finely powdered pumice stone and vinegar, and leave it for several hours; then brush it hard and wash it clean. When dry, rub with whiting and wash leather.

2. Soft soap	4	parts.
Whiting	4	"
Sodium bicarbonate	1	"
Copper sulphate	2	"

Mix thoroughly and rub over the marble with a piece of flannel, and leave it on for twenty-four hours, then wash it off with clean water, and polish the marble with a piece of flannel or an old piece of felt.

3. Sodium bicarbonate	2	parts.
Powdered pumice stone	1	"
Finely powdered chalk	1	"

Pass through a fine sieve and mix with water. Rub it well all over the marble and the stains will be removed; then wash the marble over with soap and water, and it will be as clean as it was at first.

4. To take stains out of white marble, take one ounce of oxgall, one gill of lye, one and one-half tablespoonfuls of turpentine; mix, and make into a paste with pipe-clay; put on the paste over the stain and let it remain for several days.

A strong solution of oxalic acid effectually takes out ink stains. In handling it the poisonous nature of this acid should not be forgotten.

Iron mould or ink spots may also be taken out in the following manner: Take one-half ounce of butter of antimony and one ounce of oxalic acid and dissolve them in one pint of rain water; add enough flour to bring the mixture to a proper consistency. Lay it evenly on the stained part with a brush, and, after it has remained for a few days, wash it off and repeat the process if the stain be not wholly removed.

5. To remove oil stains apply common clay saturated with benzine. If the grease has remained in long, the polish will be injured, but the stain will be removed.

6. The following method for removing rust from iron depends upon the solubility of the sulphide of iron in a solution of cyanide of potassium. Clay is made into a thin paste with ammonium sulphide, and the rust spot smeared with the mixture, care being taken that the spot is only just covered. After a lapse of ten minutes this paste is washed off and replaced by one consisting of white bole mixed with a solution of potassium cyanide (1 to 4), which is in its turn washed off after a lapse of about two hours and a half. Should a reddish spot remain after washing off the first paste, a second layer may be applied for about five minutes.

[Continued from SUPPLEMENT, No. 1225, page 19665.]

MECHANICAL INFLUENCE IN ARCHITECTURE.*

IN the early part of the twelfth century, while the builders of the mediæval churches were struggling with the difficult problems presented, a happy solution was evolved in the pointed arch. (See Fig. 7.) The many advantages of this form of arch soon became apparent, and the round arch, with all its sacred traditions and venerable service, was abandoned at once; for this new and advanced step in evolution was a necessity, reducing the thrust of the vaulting about one-half and allowing arches of many different spans to be brought to a uniform height with graceful intersections and secure construction.

The pointed arch not only solved the mechanical difficulties of this church-building age, but lent itself so naturally to the upward tendency that a new impetus was given, and churches and cathedrals, designed and commenced in the Romanesque style, were often carried up in the Gothic style to a much greater height than the original designers had dreamed of.

The intelligent application of the pointed arch to interior groined vaulting soon brought about the complete system of Gothic architecture, in which the entire load and active thrust of the vaulting are concentrated at individual points, and the weight is transmitted to the ground by slender piers, while the outward thrust is met by flying buttresses reaching over the roofs of the aisles. These flying buttresses, instead of springing from thick and massive walls, rest against deep buttresses which may be considered as so many sections of the old Romanesque walls, placed at right angles to the building line.

In this ingenious and scientific manner the thrust of

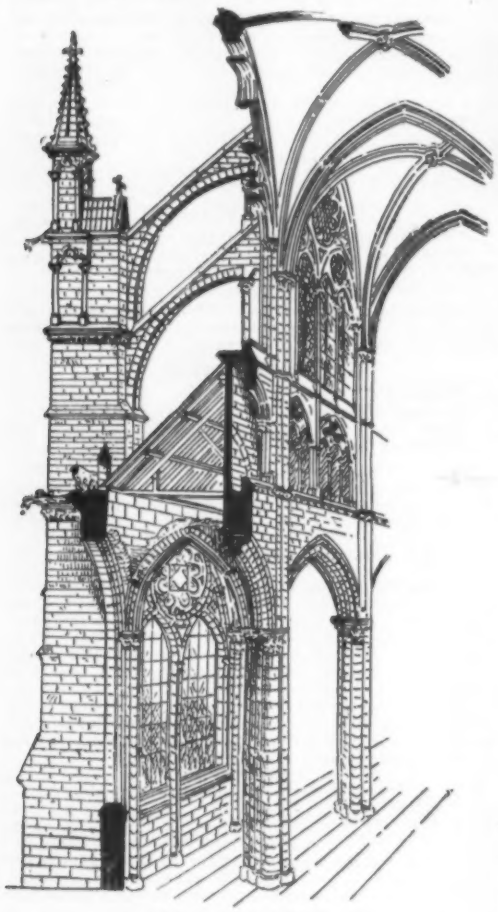


FIG. 7.—GOTHIC.

the lofty vaultings is conveyed to the ground without obstructing the light required for the building, and at the same time it produces a charming effect.

The stone pinnacles crowning these buttresses were erected, not to give variety to the outline, or simply to send up so many aspiring points, but for the more prosaic purpose of lending their weight to secure equilibrium for buttress and flying arch.

The roofs of towers, which at first were of flat pyramidal form, became elongated to the tall and graceful spires of later days, exerting less thrust on the tower walls than the earlier forms.

In the absence of overhanging cornices to shelter the walls, projecting gargoyles were placed at intervals to discharge the rain water away from the walls; and their usual grotesque features suggest the unpleasant work required of them.

In this manner we may find that every portion and detail of a Gothic cathedral has its special duty, and, in performing it, gives shape and character to the style.

As Longfellow again very truly says:

> "Nothing useless is, or low,
> Each thing for its place is best;
> And what seems but idle show
> Strengthens and supports the rest."

I have said that imagination runs riot in ascribing the pointed arch to other than mechanical origin.

The most common delusion is the often expressed idea that the intricate vaulting of Gothic work was the result of efforts to imitate the interlacing branches of forest trees.

To disprove this, it is necessary only to observe that it was not until the third and last century of Gothic work that the vaultings arrived at any such intricacy, and the steps were very gradual from the plainest possible arched surfaces of the twelfth to the elaborate fan tracery of the fifteenth century, when the builders attempted, by ingenious devices, to conceal the real and true construction.

Another very plausible suggestion of the origin of the pointed arch is that such a form was produced by

FIG. 8.—DUOMO AT FLORENCE.

the intersection of interlacing semicircular arches, as was often practiced for wall decoration in Norman architecture in England.

This indeed might have suggested the form to those who were seeking new forms.

But there was no desire to change from the round arch, made almost sacred by its long-continued use and its religious associations. And again, the pointed arch was first employed purely for structural purposes, and in France, not in England.

Other writers, including no less an authority than Sir Christopher Wren, attribute the introduction of the pointed arch throughout Europe to the returning crusaders, who, Sir Christopher says, may have seen it used in Saracenic architecture.

In answer to this, it may be said it is very doubtful, and certainly not proved, that the pointed arch was used by the Saracens earlier than in Europe, while we do know that the round horseshoe arch was then, as now, the common type.

And, as the returning crusaders did not introduce the horseshoe arch or any other device or ornament

FIG. 9.—EIFFEL TOWER, PARIS.

from the East, it is hardly possible that the pointed arch came from that source.

Others, again, have thought the lines of the pointed arch were suggested by the outline of a fish's head, because the fish forms a prominent feature in early Christian symbols.

And still others, thinking such an important feature could not have been suggested by anything "in the earth or in the waters under the earth," attribute it to Divine inspiration.

It was, in fact, such inspiration as in our day put eyes in the points of needles and gimlet points on the ends of screws—the inspiration we call invention, the child of necessity.

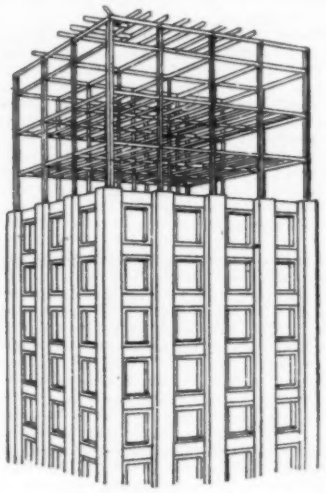
When the builders of these Gothic monuments had become so familiar with the solutions of their mechanical problems, and had expressed in stone all the structural truths they were conscious of, the spirit of adventure and novelty led them to take liberties with their materials and to produce such astonishing and indefensible features as hanging pendants and intricate fan tracery in their stone vaultings. Thus did Gothic architecture ripen and fall, and in its place no new forms arose. The attention of architects was turned toward Rome, and the illogical combination of arch and classic orders was born again to rule the building world.

I said no new forms arose. It may properly be claimed that the lofty dome, with its lantern or cupola, which forms so conspicuous a feature of the Renaissance, and which crowns its proudest monuments, such as St. Peter's at Rome, St. Paul's at London, the French Pantheon and the Invalides at Paris, is an architectural form new to the world.

We have noticed the dome of the Pantheon at Rome, 143 feet in diameter and built about the beginning of the Christian era, also the dome of Santa Sophia, 104 feet in diameter and commenced about 527 A.D. Both of these celebrated examples were flat domes without crowning lanterns.

The first indication we have of the revival of Roman architecture is in the famous work of Brunelleschi in erecting the dome and lantern on the cathedral at Florence early in the fifteenth century. (Fig. 8.)

This building, designed by Arnolfo, and built up to



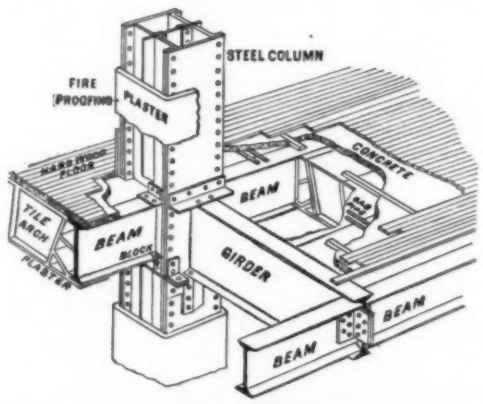


FIG. 10.—MODERN OFFICE BUILDING.

the vaultings of the nave in the Florentine Gothic style, had remained nearly a century unfinished.

The original design and model (if any were made) for covering the great central octagon, 137 feet in diameter, were lost and forgotten.

Many architects and experts were consulted, and a great variety of schemes advanced and debated.

Most of the plans contemplated a central pier or group of piers to support the roof.

When Brunelleschi, who had diligently studied the Pantheon and other works of ancient Rome, proposed his bold scheme of carrying the walls of the octagon still higher and covering it with a double shell dome, without the aid of centering or temporary supports, he was denounced on every hand as crazy, and his scheme was condemned as wholly impracticable.

After some years of discussion and agitation, he was permitted to undertake the work, which he executed with great zeal, good management and final success, although death overtook him before the lantern crowning the dome was finished. This dome at Florence furnished the model for Michael Angelo at St. Peter's, and for all modern domes in masonry.

While the Renaissance has been practiced with many variations in the civilized world for the last four hundred years, we look in vain for new architectural forms. We find only new combinations of old forms, and the question is often asked, Will a radically new style ever be invented?

If my argument is correct, that the architectural styles of the past have been developed by applying the best mechanical knowledge and skill to the materials at hand in solving the structural problems presented, then it follows that new styles may be expected only with the advent of new materials, or of new structural problems to be solved. In our own day we have both of these conditions presented in certain directions,

* By G. W. Percy, Member of the Technical Society of the Pacific Coast. [Read before the Society, March 3, 1899.] From the Journal of the Association of Engineering Societies.

and we shall see how new architectural forms are being developed.

The new material presented to the builders of our day is metal. It is only about fifty years since iron was first considered a possible material for architectural forms.

At first it was cast in the well known shapes of columns, arches and entablatures and set up as hollow shams, painted and sanded to look like stone. This was not good art or good mechanical application, and therefore it could not produce a living style.

Iron and steel, however, were constantly demonstrating their worth under the hands of skillful engineers, and the proper forms for utilizing their good qualities were found to be with the wrought metal rolled into bars, rods, flanged beams, angles, etc., and put together with bolts and rivets. With this material, the mechanical engineers have solved the problem of spanning rivers and chasms that would be impossible with stone; as, for instance, some of the bold bridges across the Mississippi, the graceful suspension bridge between New York and Brooklyn, and the stupendous cantilever bridge over the Firth of Forth in Scotland, with its two spans of 1,700 feet each and trusses over 300 feet high. The Eiffel Tower in Paris (Fig. 9), 1,000 feet high, gives us, indeed, new architecture, but a form that will meet only a few limited conditions.

Similar applications of iron or steel to the problems of the day have given us the great clear spans of our central railroad stations, and of large buildings, as in the roofed court of the Manufactures building at the Columbian Exposition at Chicago, where the clear span was 380 feet and the height over 220 feet.

This naked condition of beams, bars and rods, as applied to roofs, bridges and lofty towers, is not adapted to the general problems of domestic, commercial or monumental buildings, except as an auxiliary, and in the requirements of the modern office building it is an important one.

The prime object of the modern office building is to earn the greatest possible return for its owners. This means that it must present the greatest rentable space possible on the lot, with every part well lighted and ventilated, easy of access to all parts, fireproof and secure in its construction, with every modern convenience for its occupants, and with a good degree of elegance presented to those who enter it. (See Fig. 10.)

The attainment of this prime object has been greatly enhanced by the very modern steel skeleton construction, making buildings twenty stories high as safe and practicable as those of five stories by the old method, while the rapid-running elevators, in sufficient number, make the top stories as accessible as was the fourth or fifth under the old method.

Here we recognize the conditions possible for a new style, and the first important steps have been taken in some of the modern sky-scrapers, by ignoring all historic styles, and developing the simplest possible form, as in Fig. 10, by clothing the skeleton frame with the necessary flesh and skin of brick and terra-cotta. But, as this covering skin is the old historic material, it is hardly probable that the detail or ornament applied will differ much from that with which we have been made familiar, and it remains to be seen what this age of metal will develop.

As we commenced with a style worked out in bamboo, we end with a style being developed in steel, and we may feel assured that, as every historic style has been the result of continuous application of correct principles applied to the materials and conditions imposed, modern science will work out as satisfactory solutions of its problems.

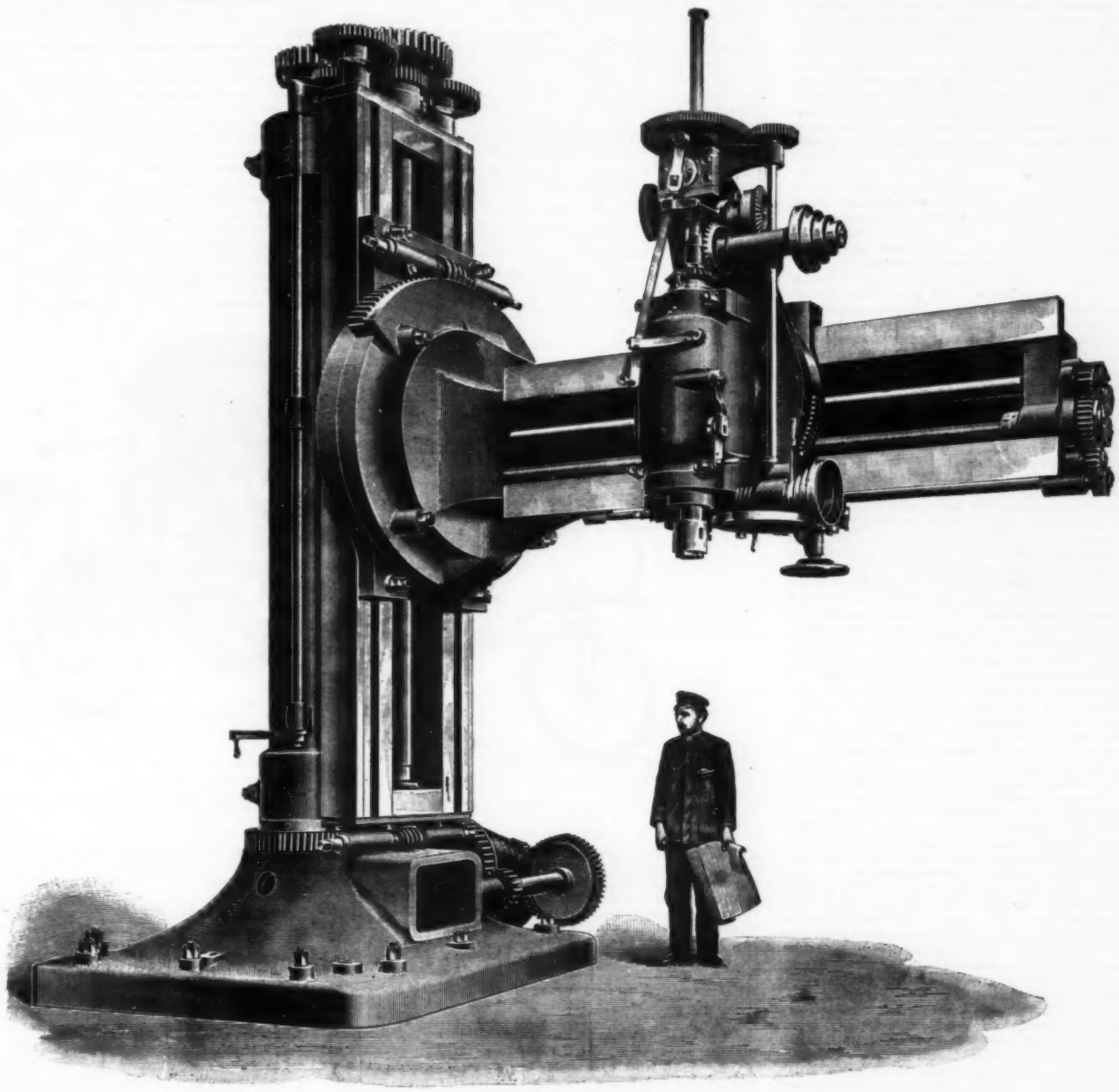
An Aluminum Hand Car.—An aluminum railroad hand car is being built by the St. Louis Aluminum Casting Company, and the makers propose its adoption by railroad companies to take the place of the ordinary muscle-taxing contrivance used by track workers. The new car will be constructed largely of an aluminum alloy of great strength and lightness, that is, the wheels, body, and walking beam will be made of this metal. The axles will be of steel tubing. Other improvements will consist of gearing of the bicycle pattern, admitting of adjustments for speed, of ball bearings, and of a hub brake, whereby brake power may be applied by simply pressing a button. The new car will weigh not more than 150 pounds, or only about a third as much as the ordinary hand car, and one man can lift it off or on the track. It is believed that two men can easily run it from thirty to thirty-five miles an hour for a limited time.—Journal of the Franklin Institute.

In the new automobile cabs in Paris there is an arrangement in the interior of the vehicle which enables the passengers to check the speed or even bring the vehicle to a standstill, independently of the action of the motorman. It seems that this is due to the reckless speeds with which these vehicles are being driven. There is another novelty in the form of a register which is placed at each cab stand, in which the patrons may enter any remarks or suggestions, the object of the company being to obtain their opinions.—Electrical World.

RADIAL DRILLING MACHINE.

THE boring and tapping machine which we illustrate was built this year by the Russian Locomotive and Engine Works, of Charkow, which are under the management of Mr. P. Rizzoni. The machine, says Engineering, is constructed for boring holes and cutting threads in armor plates in the bent state. The boring spindle can be driven at ten different speeds by the intermediary of a five-step cone pulley and of various wheel gears. The arm, which moves up and down, can be turned through an angle of 100 degrees. The slide can be adjusted radially both by hand and power. The spindle is balanced; it is put in gear automatically or by hand by means of worm gearing. Its own motion can be varied by a four-step cone pulley. There is a special device for promptly releasing the nut when cutting threads up to 6 inches in diameter, for which purpose a screwed tool is employed. This device is also made use of when the boring spindle is to be shifted longitudinally, independently of its coupling mechanism. A handwheel has been provided for this operation. The device renders essential service in drilling deep holes, as the tool can quickly be fixed at various heights, and the borings can be removed at short intervals. The chief dimensions of the machine are as follows:

Diameter of boring spindle	160 mm. (6·3 in.)
Vertical travel of boring spindle.	700 mm. (27·6 in.)
Maximum radial range	3,750 mm. (12 ft. 4 in.)
Maximum elevation of boring head above floor	3,200 mm. (10 ft. 6 in.)
Vertical travel of arm	2,000 mm. (6 ft. 6 in.)
Weight of machine without bedplate.....	38 tons.



RADIAL DRILLING AND TAPPING MACHINE.

MOTOR CARRIAGES AND STREET PAVING.

By THOMAS CONYNGTON.

THE number of motor vehicles already in use in this country and elsewhere indicates clearly that their general introduction is but a matter of time. In Europe they are much more common than here. In Paris, on occasion, the fashionable drives will show almost as many motor carriages as vehicles of the ordinary build, and in other European cities the prohibition of horses on certain drives is under serious consideration. In England and in France several periodicals in the interest of motor vehicles are regularly published, and the nature of their contents and the appearance of their advertising pages indicate that they are success-

fully filling a popular demand. In the United States one attractive monthly is devoted to this subject.

It will be remembered that in this country much attention was called to certain public trials of motor vehicles, both at Chicago and New York, in which the results, though not entirely conclusive, were very encouraging. In New York city the public have been served with electric cabs for two years or more. These cabs, though at first apparently constructed on the lines of a steam road roller, have been fairly successful and in their present more attractive form are now well patronized. The public have become so accustomed to their smooth and noiseless passage through the streets that they attract hardly more attention than do the old Fifth Avenue buses. Quite frequently, too, on the residence streets and on the fashionable drives, lighter and more elegant motor carriages may be seen, holding their swift and easy course among and through the heavier and equine-cumbered equipages of the avenues.

Within the last twelve months much greater progress has been made in the introduction of these harbingers of an advanced civilization than appears on the surface. A large number of companies and firms have been organized for the express purpose of manufacturing these carriages and bringing them into general use. At the present time there are in this country more than forty separate organizations working toward these ends, each with its own special carriage or motor and each bent upon the speedy exploitation of their particular machine. One prominent manufacturer whose singularly accurate judgment in regard to the future of the bicycle has brought him fame and money, is reputed to have secured contracts on several of the most valuable European patents, and his company is already in the market with a high-priced but very successful motor carriage. Also quite recently much speculation has been caused by the appearance, apparently in conjunction, of Mr. Leiter, of wheat-corner fame, and Mr. Croker, of Tammany, in the new field of automobile conveyance. Beyond all this, and perhaps even more significant, the motor carriage has risen from its former position in the popular judgment as an expensive fad to that of the coming conveyance.

With the variety of machines that are now being offered, or about to be offered, there is a remarkable diversity of motor power. Most of the carriages use petroleum or gasoline motors, cheap to operate and very effective, but a little odorous and occasionally troublesome to manage. Some experts declare in favor of a lightly constructed steam engine, while a larger number favor the use of electricity, with its necessary accompaniment of heavy, cumbrous, and troublesome storage batteries. Lately organized companies are to be operated by compressed air. Beyond all this are many rumors of motors yet to come, using various kinds of gases, combustibles, and even explosives.

The future of the motor carriage demands some imagination. This generation has seen the telephone, the electric motor, the electric light, the bicycle, and hundreds of lesser inventions, almost revolutionize existing conditions. In view of what has been done, and of the present status of the motor carriage, and of the field that is open to it, the anticipation of its widest and most general introduction does not seem unreasonable. There are no fundamental patents controlling these machines and restricting their general manufacture and sale. True, hundreds of patents have been issued, and more hundreds will be issued, but it is possible to-day for a skilled mechanic to build a practical and successful motor vehicle without infringing any of the existing patents, just as he can build a steam engine, or a bicycle, or a mowing machine. This means that there will be no monopoly of the business, but that the machines will be put on the open market to be sold on their merits and at reasonable prices.

At present the price of the motor carriage ranges from $500 up well into the thousands. As soon as the scale of manufacture is sufficiently increased to permit the parts being made by machinery and in quantity, these prices will undoubtedly be very greatly reduced, probably to such a figure that the man of very moderate means will be able to maintain his own motor carriage without even suspicion of extravagance.

The general introduction of these vehicles would work an industrial revolution. The horse and the industries dependent upon his use would almost pass away. New factories, new repair problems, and the greater skill required in the constructive and repair work of these machines, would call into activity an immense number of skilled operatives, with a correspondingly increased scale of wages.

The most interesting phase of this question is, however, the effect produced by the general use of motor vehicles upon the ever-present and very important problems of street paving, maintenance, and cleaning. At present the effect of the horse's hoof on paved surfaces is one of the most serious difficulties confronting the municipal engineer. If an effectual method of destroying our streets was desired, it is doubtful whether anything better could be devised than the hammering, cutting, twisting, and grinding of a horse's feet. Take a ponderous draught horse, weighing close to a ton, shoe his four feet with heavy, sharp-cornered, iron plates as a traction base, harness him to a heavy truck, put on a heavier load and then start him pounding, denting, twisting, and scraping from morning to night and you have a very efficient engine of destruction. All of our paving construction is largely affected by this factor. The granite block pavement, with all its variations, has no other raison d'etre for its existence. Asphalt, paving brick, and the other modern pavements are very greatly modified by the necessity of guarding against the destructive action of the horse's hoof.

Nearly all the repairs required by the modern pavement are due to this cause and in a lesser degree to the iron-tired wagon wheels with their angular edges. The hardest granite blocks grind off until too uneven for use and are then either resurfaced with asphalt or relaid. Paving brick wear out, and where there is the slightest softness go to pieces. Wherever a weak spot occurs in the asphalt it is found out by the hoofs of horses, and the pavement is only preserved by the most constant maintenance; while macadam streets and roads can hardly be maintained in even tolerable condition.

It is further true that nearly all the sanitary difficulties of our streets are caused by the use of the horse. The constant accumulation of filth and the continual mud or dust resulting from attrition demand constant and unflagging attention to keep our streets in even passably decent condition. Nearly all these ills of dust and mud and evil odors, with their unhappy effects on the health and temper of the residents, are to be charged to the use of the horse.

With this state of affairs may be contrasted the conditions that would exist with the general use of motor vehicles. It is possible that this will eventually result in the legal prohibition of horses on our business thoroughfares, with an immediate and most important change in the construction of our street pavements. Granite and stone blocks in all their forms would be abolished. Paving brick would be laid on lighter foundations and with greater smoothness. Asphalt, above all else, would be the predominant pavement; perhaps more lightly laid and at less cost; macadam and gravel, rolled as smoothly as possible and disturbed by nothing more injurious than a rubber tire, would develop possibilities now undreamed of. Even an ordinary dirt road, properly graded, rolled down and drained, would be very tolerable in all except the very worst of weather.

The improvement in city conditions by the general adoption of the motor carriage can hardly be overestimated. Streets, clean, dustless and odorless, with light, rubber-tired vehicles moving swiftly and noiselessly over their smooth expanse, would eliminate a greater part of the nervousness, distraction, and strain of modern metropolitan life. Not only would the improved street conditions contribute to better health, but also the existence of this ideal vehicle, light, rapid, powerful, easily handled, economical in operation, reasonable in its first cost, and cheaply kept and maintained, would in itself greatly increase outdoor exercise of the most agreeable and healthful kind with resulting benefit to both physical and mental man. May the day soon come.—Municipal Engineering.

A TRICYCLE CARRIAGE FOR THE AMEER OF AFGHANISTAN.

THE Ameer of Afghanistan does not cycle like the common herd. He is getting stout, and the doctors have ordered him to take gentle exercise. But the

A TRICYCLE CARRIAGE FOR THE AMEER OF AFGHANISTAN.

Ameer intends to carry out the orders with as little discomfort to himself as possible, judging from the carriage that has been built for him by Messrs. Laurie & Marner, of Oxford Street, London. This is something like one of the old Georgian phaetons, only the motive power is to be looked for behind, instead of in front. The bulk of the propulsion of the vehicle will be done by two specially selected stalwart Afghans, who will pedal behind their sovereign and receive their orders through an unglazed window. When His Highness feels inclined he can assist in the work of pedaling two footboards, which are connected to the general mechanism. They rise and fall while the cycle is in motion, so that all the Ameer need do is to give them a push from time to time. He can do this while lounging on silk cushions. Besides the carriage for his personal use, the Ameer has had another built for the use of members of his harem. The carriages have cost £200 each, are capable of attaining a speed of twelve miles an hour, and are to be shipped to India by the next mail steamer.—St. James's Budget.

THE PROGRESS OF ALUMINUM.

IT was scarcely possible some two years ago to take up a newspaper or magazine without discovering some marvelous account of the new metal, wherein the credulous reader might learn that aluminum was stronger or weaker, lighter or heavier, cheaper or dearer than anything else; and that it was evidently pre-ordained to replace sodium, or zinc, or steel, or lead, or platinum, or gold. The technical periodicals naturally had a far acuter sense of their responsibilities, and the cynical student might easily read between the lines of many of their articles a curious unanimity of opinion that aluminum was a most useful and valuable metal, ought most certainly to be adopted at once and in large quantities—preferably in some other trade first. The optician pointed out that aluminum was his earliest love, but being too soft to carry a good screw, he must sadly resign his claims in favor of the typewriter maker, whose instruments were outrageously heavy. The typewriter manufacturer regretted that aluminum was too elastic for him, but it was eminently suited for the shipbuilder; and so on. The boom has now almost ceased; the irresponsible writer has found a fresh craze, and in spite of its ill treatment at the hands of the press, whose caresses might readily have smothered it, aluminum has proved one of those sturdier children, capable of surviving the ignorance of parents and the diseases of infancy; and it is now ready to hold its own, not against all comers, but against "persons of its own size."

In 1897 The Engineer stated that there were five distinct firms engaged in its manufacture, that they all employed practically the same method, and—assuming rashly the prophet's mantle—that there seemed no prospect of a successful rival. Hitherto our forecast has proved correct. Aluminum is still won by electrolyzing a bath of purified alumina, prepared from bauxite, dissolved in molten cryolite, or some similar double fluoride of the metal; and as time goes on there appears even less danger of this Héroult-Hall process being superseded. At the time of writing three schemes had been lately brought forward, which we criticised and rejected; nothing further has been heard of them. Shortly after going to press a yet further plan was described with some circumstance of detail in The Journal of the Society of Chemical Industry—March, 1897—by H. S. Blackmore. He proposed dissolving or suspending alumina in a molten bath of alkali sulphides, fluorides, or chlorides, and passing in a current of carbon bisulphide vapor, in order to convert the aluminum oxide into a sulphide. He also outlined, as a necessary part of his process, a method of producing the bisulphide, by means of which the cost and trouble of preparing this reagent should be brought within reasonable limits. The aluminum sulphide was either to be reduced electrolytically, or its solution in one of the above-named salts treated with molten iron run in through a fire-clay sieve, so as to break it up into a kind of rain. We have already discussed the feasibility of manufacturing aluminum by electrolysis of the sulphide; and we have no reason to alter our previous opinion that the extra labor and expense involved in preparing it would neutralize the economy possible during its reduction to the metallic state. The idea of reducing aluminum sulphide metallurgically with iron is by no means new; but the most conclusive argument against its commercial utility lies in the fact that although Mr. Blackmore stated that his process had gone beyond the experimental stage, and that it would immediately be in operation on the large scale, we have yet to learn that non-electrolytic aluminum is on the American market. In fact, since February, 1897—the date of Mr. Blackmore's communication—the Héroult-Hall process has not been attacked seriously.

Since the publication of our last article in May, 1897, additions to the original literature of aluminum have not been very copious; and, probably, the only contributions of much all-round importance have been a paper read before the London section of the Society of Chemical Industry, in March, 1898, by Mr. Wallace, the chairman of the British Aluminum Company; and a communication to the Institution of Mechanical Engineers, read last summer by Mr. Ristori, the managing director of the same concern. The latter of these consisted essentially of a description of the rolling mills and foundry for crude aluminum built by the British Aluminum Company, at Milton, Staffordshire, a brief résumé of the methods adopted in working up the metal into its final shapes and a sketch of its more important uses. The former contained a description of the Héroult process, a short history of aluminum, and an account of its physical and chemical properties; the two together, therefore, forming a more or less complete survey of general knowledge respecting aluminum and a few of its alloys. Considering them accordingly as a single monograph, we notice one striking feature. This is almost the first occasion during the life of aluminum that a fresh communication on the subject has not been made with the aim of introducing some totally new method of production to the affrighted ears of existing manufacturers and shareholders. Without looking at the matter solely, or even principally, from the standpoint of the British Aluminum Company, this state of affairs is highly satisfactory. Mr. Wallace's remark that the Héroult process has absolutely no competitor only bears out our own earlier expressed view. The makers are settling down to steady routine work, and are turning out their product at a fairly calculable price; so that they merit attention at the hands of those engineers who desire a light and non-corrodible metal or alloy. One of the most prominent trains of thought running through Mr. Wallace's paper, if we may say so without disparaging the remainder, is a feeling of gratification at being the monthpiece of the first company to exploit water power on a large scale in the United Kingdom. Niagaras and Schaffhausens do not exist in all parts of

the world; it is not practicable everywhere to form reservoirs capable of holding 4,000,000,000 gallons; nor is it given to everybody to purchase the water rights over twelve square miles of country. Yet there is surely more than one district in Great Britain which would repay a careful study of rainfall and contours, with the aim of erecting turbines and dynamos to carry out some electro-chemical operation. There are many, perhaps an increasing number, of industries in which the power absorbed forms a very appreciable proportion of the total cost of the marketable product; and if the employment of a waterfall which can be worked, as Mr. Wallace finely says, "without fear of exhaustion as long as the sun continues to shine and the rain to fall," shall reduce the energy bill to "a fraction" of its existing dimensions, it behooves every such manufacturer to be on the alert before all the best localities are occupied. The utilization of water power in this country for electric lighting has not been an unqualified success; but conditions here are widely different. An electrolytic process goes on quietly and uniformly throughout the week; it knows nothing of fog; of "early closing;" it takes no thought of night and day. Questions of freight, etc., have, of course, to be considered. But water carriage is cheap; the manufactured substance usually weighs less than the raw materials, and it may often pay to erect the plant near to the sources of supply or power rather than close to the consumers' market. The British Aluminum Company, therefore, deserves every credit for demonstrating that, although it has a monopoly in the preparation of aluminum, yet coal cannot be regarded, even in Scotland, as the only available source of industrial energy.

The efficiency of the Héroult process seems steadily to be rising. The actual yield of metal is quoted by Wallace at 1 lb. per 12 E.H.P. hours; the working tension of the current at from 3 to 5 volts; the temperature of the bath between 750° to 850° C. Thomson's latest determination of the atomic weight of aluminum is 26·77 (H = 1), which is notably lower than that obtained by previous observers; and accepting this figure, the electro-chemical equivalent of aluminum becomes log. 5·96697 grammes per coulomb. The lowest temperature at which Richards has recorded the theoretical voltage of liquid alumina is 900° C., when it is 3·05 volts; deducting the heat of formation of carbonic oxide expressed in electrical units (= 0·65 volt), the net voltage of the Héroult cell for electrolysis alone becomes 2·4; so that the theoretical output of aluminum per E. H. P. day of twenty-four hours is 5·487 lb. Taking the mean of Wallace's voltages (4·0) for the normal strength of the current, the energy efficiency of the process works out at 36·45 per cent., and the current efficiency at 60·07 per cent. On a previous occasion, dealing with the manufacture in the United States, we gave the figures of the identical Hall process as being 22·7 per cent. and 40·6 per cent. respectively. These were calculated from the conventional voltage—for alumina—2·8, and the older atomic weight 27·02; but as the two differences tend to neutralize one another, the American and the English results may safely be compared together, and so a fair insight can be gained into the progress of the aluminum industry even during the last two or three years. This is still more strikingly brought out from the practical side by Wallace's statement that in 1890, 40 tons of aluminum were made and sold at £1,083 per ton, as against 2,500 tons in 1897, selling at £148 per ton; while at Foyers they are able to manufacture the metal more cheaply than either at Neuhausen or Niagara, although the two latter firms have had considerably longer experience.

In the year 1892 a pamphlet entitled "Proposals for Utilizing Water Power in Southern India" was issued by Prof. Chatterton, of the College of Engineering, Madras, whose idea was that part of the energy procurable from the Periyar Irrigation Works should be devoted to the manufacture of aluminum, using as ore the enormous deposits of corundum which occur in the southern parts of that country, and which have been exploited for generations as a source of emery. Chatterton considered it probable that 40,000 tons of this corundum could be obtained per annum, at a cost not exceeding £10 per ton; but he suggested that should this material prove unsuitable for reduction, bauxite might be imported from Europe or elsewhere, which, he thought, could be done for about £20 per ton, delivered at the site of the water power. In 1893, a committee consisting of Profs. Unwin, Forbes, and Roberts-Austen, with Col. Pennycuick, appointed by the India Office, reported on this scheme. Pennycuick estimated the capital cost of the energy at £4, or the annual charge at about 10s. per horse power year; Roberts-Austen calculated that aluminum could be won for 13·6d. per pound, but added that "very grave considerations were presented by the nature of the material it was proposed to employ."

For one cause or another, the project seems to have been abandoned, and nothing is heard of it at the present time. Mr. Chatterton, however, not desiring to let the matter drop altogether, has busied himself with the education of the natives; and, as frequently reported in the Indian papers, has instituted classes for teaching the local metallurgists how to work aluminum obtained from Europe. According to The Times of India, "Mr. Chatterton's exertions have already—June, 1898—met with such prompt recognition that he has been able to employ about 100 artificers in working up the metal at the School of Instruction, and to turn out aluminum vessels by the ton, which command a ready sale. A very keen appreciation of the advantages of the new white metal has been shown in Madras by natives as well as Europeans; and, indeed, those advantages are so obvious, that once aluminum vessels have been put on the market at a moderate price, they are sure to be in large and increasing demand." Imported cooking utensils have not proved entirely successful, for if the articles are not made exactly of the right shape to please native ideas, they are looked upon with much disfavor. The annual amount of copper, zinc, and tin imported into India is nearly 32,000 tons, two-thirds of which is worked up in the bazars into domestic vessels of copper, brass, and bell metal. In a land full of prejudice and ignorance, it is clearly better to create a demand for any particular material first, trusting to a supply being forthcoming subsequently, rather than to attempt to force the said material on to the markets in order "to support home industries." Mr. Chatterton appears to have succeeded in his recent and more expedient course of action; and if only 10 per cent. of the imported copper, etc., can be replaced by aluminum, as seems possible, there exists already a respectable nucleus of trade for the aluminum manufacturer in India.

The possibility of introducing some new profitable industry in a British colony affects a far wider circle than those persons who might be directly interested therein; and we offer no apology for discussing this matter in some detail. In the government report just referred to, Prof. Roberts-Austen inferentially threw cold water on the scheme—first, on account of the expense of manufacturing the metal, and, secondly, on account of the ore. His calculation of the cost was given side by side with an estimate by Capt. Hunt of the manufacturing price per pound of aluminum then ruling at Pittsburg. These we reproduce:

	India. d.	Pittsburg. d.
Energy	1·1	2·5
Alumina (2 pounds)	6·0	3·0
Electrodes	2·0	1·0
Chemical stores, etc.	1·0	0·5
Labor and superintendence	1·5	1·5
Interest and maintenance	2·0	1·5
	13·6	10·0

If this calculation were made over again, the first item would be considerably reduced; in 1893, 1 pound of finished aluminum absorbed 22 E. H. P. hours at the bath, or about 26 horse power hours at the turbine; now the yield is 1 pound per 12 E. H. P. hours. But the main difference between the two is in the cost of the ore. During the discussion on Mr. Wallace's paper last spring, the author stated that pure alumina prepared by the Bayer process from Irish bauxite cost the British Aluminum Company about £12 per ton, which seems to show that Mr. Chatterton's estimate of £20 per ton delivered in India is not too low. If we accept this figure, taking the present cost of energy at 0·6d. per pound, and the other items as in 1893—the electrodes and stores would certainly have to be imported, and no economy could be effected in that direction—the cost of aluminum reduced in India from European alumina should be about 11·4d.; or if the native corundum were available at, say, £12 per ton, about 9·6d. Looking at the matter from the national aspect, the scheme of reducing aluminum in India is only of great importance provided the native deposits can be utilized; the question, therefore, is, Are they suitable? Roberts-Austen said in his report that he had analyzed a sample of corundum from the Salem district of Mysore, and found it of a high degree of purity, but had no means of ascertaining whether it was an average specimen. Within the past year or so, further samples have been forwarded to the Imperial Institute, where, we believe, they are open to inspection by anybody concerned. Hitherto, no fresh analyses have been carried out, or at least published, nor has any attempt, so far as we are aware, been made to study their behavior in the Héroult cell. We are not dealing here with the question of patent rights; possibly these are held by the European makers, but as the Héroult patents cannot have many more years to run, it should be well worth investigating the character of Indian corundum, if only to provide an outlet for the vast store of native labor lying idle in that colony, on other than temporary and purely charitable lines.

At the beginning of last year Mr. Hunt, of the Pittsburg Reduction Company, made a communication to the Institution of Electrical Engineers on the subject of aluminum as a rival for copper and brass for electrical conductors. He stated that his company was prepared to sell aluminum for this purpose with a guaranteed conductivity of 63 (copper = 100) at 29 cents per pound, as against the price of 14 cents per pound for copper wire then obtaining in the States. From these and the other necessary data he calculated that 1 mile of No. 10 B. and S. gage (diameter 0·1 inch) copper wire weighing 162·32 pounds and costing $22.73 would do the work of 1 mile of No. 8 (0·126 inch) aluminum wire weighing 79·46 pounds and costing $23.04. The aluminum would have an equal tensile strength per unit of area with the copper—32,000 pounds per square inch; so the adoption of aluminum should lead to a reduction of 52 per cent. in the weight, a gain of 60 per cent. in the strength, an increase of 26 per cent. in the diameter, and practically no difference in the cost of the bare conductor required for a definite amount of electrical current. He described certain forms of joints to avoid the undoubted difficulty of soldering, suggesting that the wire ends should be wrapped round with sheet metal, and the whole twisted up tightly and protected from air and moisture. The conclusions arrived at in this paper were contested by Kershaw, who, taking the costs per pound of aluminum and copper at 15·85d. and 5·94d. per pound respectively, and the conductivity of 99 per cent. aluminum at 59, found that instead of the expense being about the same, aluminum was one and one-third times as costly as copper. With reference to this matter, it may be pointed out that Lord Kelvin's latest determination of the conductivity of 99·7 per cent. aluminum is 60·5 per cent. that of copper, volume for volume;* and that as this degree of purity may be taken as a fair average of the best grades of commercial aluminum purchasable, Kershaw has unnecessarily depreciated, as Hunt has appreciated, its relative electrical capabilities. The further difference between the two results turns simply on a question of fact—as to what are exactly the current market prices of pure aluminum wire and such grades of copper as may be selected for electrical purposes. Dealing with the same point, Russell showed that no correction had been made by Hunt for wind pressure; and in the case quoted above, this—at 30 pounds per square foot—would be 0·1045 pound per foot run of copper with a safe working strain of 63 pounds; or 0·1268 pound and 100 pounds per foot run of aluminum. There would consequently be no saving in poles, as the smaller weight would be compensated for by the greater side pressure. Turning to the idea of aluminum alloys of increased tensile strength in comparison with hard drawn copper at 97 per cent. conductivity, and assuming that the prices and specific gravities remained unaltered, Russell discovered an increase of 10 or 15 per cent. in cost against the adoption of aluminum. The latter metal, of course, can only be a competitor with copper for conducting currents of electricity when the mains are bare; if they must be insulated, the copper is unapproachable by reason of its smaller area and surface. Whatever the precise economic position of the rivals, aluminum has been employed as a conductor for telephone work, and also on a large scale for heavy currents at Foyers, Pittsburg, and in Germany; and, the reports say, with perfectly satisfactory results. In one of the electrical installations at Niagara Falls the dynamos at the bottom of the turbine shaft are connected with the plant at the top by means of aluminum bars, 25 feet long by 6 inches by ⅛ inch, bolted and riveted together. Cables 1¼ inches in diameter are also used, the joints being formed by setting the ends into sockets and pouring in molten tin. Aluminum has also been selected for the conductors required to transmit a 30,000-volt current from the generating station of the Snoqualmie Falls Power Company—Washington Territory, U. S. A.—to the towns of Seattle and Tacoma, which are situated more than 20 miles distant. This will probably form the first application of the kind anywhere in the world.

The largest outlet for aluminum, in all probability, still remains in the metallurgy of iron and steel. In foundries the use of some 1 pound or 2 pounds of aluminum per ton of iron has become almost universal, and according to Wallace, often reduces the scrap by 90 per cent. In steel castings 1½ ounces or 2 ounces per ton are similarly employed, and spongy castings are beginning to be things of the past. It is said that Bessemer steel usually requires rather more aluminum than similar qualities of open-hearth steel to produce a given effect; but it is necessary to try experiments in order to arrive at the proper proportion, for the aim should be to add just enough to remove oxygen without leaving any to appear in the analysis of the finished iron or steel. The next largest field is in the manufacture of cooking utensils of all kinds—a sphere for the metal on which we need not enter again. Aluminum saucepans, etc., are to be seen in many ironmongers' windows, they have been received with approval by chefs and amateur cooks, and they are even recommended by authorities in the ladies' papers.

Opinions still seem to differ regarding the exact value of aluminum for shipbuilding. In the construction of the internal or merely decorative parts of sea-going vessels, and for such launches or boats as are used occasionally or on fresh water alone, especially when they are needed for transportation or porterage, there can be no doubt as to the suitability of the metal. Moreover, recent experience gained in the Spanish-American war shows that as a substitute for inflammable wood on warships aluminum is most desirable. Similarly, for the above-water parts of such boats as must be built as lightly as possible, racing yachts, etc., aluminum is indicated. The point in dispute is whether the metal can judiciously be adopted for sheathing and frames. Reports as to the condition of the American yacht "Defender," which has recently been overhauled, say that—as might have been foreseen—where the aluminum has been in contact with other metals, as in deck traces, it is corroded; even when not in contact with other metals, "a rust-like deposit has been found." Discussing this matter in the paper already quoted, Mr. Ristori explained the earlier failure of aluminum as being due to the unfortunate selection of an alloy containing 6 per cent. of copper, which was employed to gain strength—14 tons per square inch—but which was absolutely untrustworthy in salt water, owing to the rapid corrosive action set up between its two ingredients. Mr. Ristori also made another point by the observation that, copper alone excepted, all other metals are painted before being placed in the sea; and that if the aluminum had been protected from direct contact, it would have lasted much better—a proposition nobody can deny. Explanation of the comparative decay of the "Defender" is still to seek; impure metal containing sodium and (or) silicon is suggested. It therefore remains for the manufacturers to show if they are in a position now to supply a grade of sufficiently pure aluminum at a reasonable price which shall justify shipbuilders in employing it.

Some of the wonderful alloys—"new metals" is the orthodox term—introduced to an admiring world with great flourish of trumpets and syndicates, have disappeared; but their places are occupied without delay. Among the more recent of these is a mysterious production made by melting aluminum in a steel crucible "in a specially constructed furnace," and adding a very small percentage of "something" in powder. From the accounts, this should seem to be but highly refined aluminum itself, purified may be by simple fusion under the "something" which was suggested by Le Verrier some years ago; if so, we dealt fully with the process in our 1897 articles. The finished material is claimed to possess a tensile strength of about double that of ordinary aluminum; and it is also, of course, capable of being "brazed."

Attempts to discover a really permanent soft solder are constantly being made, and at frequent intervals the problem is stated to be finally solved. Excuses, too, are a trifle illogically put forward at the same time to explain why the metal is so difficult to solder effectually, viz., the high heat conductivity of aluminum, and the fact of its always being coated with a thin invisible film of oxide, "which none of the ordinary soldering salts will remove." Aluminum does not conduct heat so rapidly as copper, and even massive articles of the latter material are sometimes handled by the tinsmith; alumina, also, though perhaps not amenable to rosin or chloride of zinc, is, according to the chemists, fairly soluble in acids, and such (acid) "fluxes" are employed when black iron is treated with the bit. The truth is—and more judicious authorities do not seek to mask it—that all low temperature solders are highly electro-negative to aluminum; and while no doubt several ternary alloys will yield a strong and sound joint when first applied, unless the goods are preserved in a vacuum or over some hygroscopic body, sooner or later galvanic action must arise and cause disintegration. Autogenous soldering, or "burning," does not suffer from this defect, and is therefore worthy of attention. But when once the difficulty of soldering aluminum, in the ordinary sense of the word, is recognized as being to a large extent inevitable, manufacturers and users will quickly find

*This result has also been recently confirmed by E. F. Northrup, who, writing in The Electrical World, has recorded the conductivity of Pittsburg aluminum at 61·51 per cent. that of copper.

that there are equally satisfactory methods of joining two pieces together.

The employment of sheet aluminum in place of lithographic stones is spreading and becoming more popular. During the past autumn an exhibition was held by the proprietors of the English patent for preparing the metal in such a way as to enable it to take the ink kindly; and the experts appear to have been highly pleased with the specimens and results. The "algraphic" plates are used in America on rotary presses at a speed of 1,500 or 1,800 impressions per hour; at the end of a job they can be cleaned ready for fresh service without the expense of re-grinding; the same plates can be employed 200 or 300 times, and if they have to be preserved, 150 can be stored in the space occupied by one stone. Aluminum is at present being drawn on to steel tubes in the States for cycle work, etc., and reports say that it is drawn over wood in this country. Some years ago it was thought that powdered aluminum should be a useful substance for producing the "flash light" required in many photographic operations; recent exhaustive experiments, however, go to prove that the advantages lie with magnesium as of yore.—The Engineer.

A VISIT TO THE QUARRIES AT BEDFORD, N. Y.

By ALICE DINSMORE.

THE station Bedford, on the New York and Harlem Railway, with its little group of buildings near, gives no hint of what lies beyond the hill that rises abruptly from the track. A mile or more away is the village, with its old court house, its two or three churches, its comfortable homes, some with pillared fronts, others of modern fashion—all set in spacious lawns, beautified with trees.

The town straggles along one or two streets for a little distance, and then a succession of rolling fields to the hills that in every direction fill the horizon. Here and there an outcrop of ragged gneiss appears among the trees that crown most of these foothills of the Berkshires. With these beautiful surroundings, a rather sandy road winds up and down to the quarries worked by Mr. Kinkel. Here a party of members of the New York Mineralogical Club and the Mineralogy Department of the Brooklyn Institute were most kindly entertained on Memorial Day. Quartz and feldspar—chiefly orthoclase—lie close together on the hillsides which have been worked for about thirty years. The variety rose quartz, of very rich color, is taken out in large pieces, some beautifully translucent, and great masses of it lie in situ. Much of the quartz is penetrated with black tourmaline. The president of the club identified one large black garnet that a workman had found, and small specimens of columbite were also among the same man's collection.

We saw fragments of beryl crystals that had fallen under the blow of pick or powder, and were shown where an immense crystal of beryl, weighing several hundred pounds, was taken out very near the surface. Manganese is represented by dendrites on feldspar.

The specimens which we brought away of most interest were autunite, its yellow-green surface at once suggestive of the uranium ores, and the very beautiful masses of graphic granite.

The feldspar in which the cuneiform-like bits of quartz lie is a rich flesh color. The cleavage is so easy that we obtained large pieces in which it requires no very vivid imagination to read an inscription older than any found on Assyrian monument or Egyptian sarcophagus.

While the party was not fortunate enough, I believe, to find any fine, perfect crystals, some were found of great interest to the student. Among these were small, curved quartz crystals, and others showing well the arrest in crystallization, three or four sides of the hexagon lying flattened on a mass of feldspar, instead of having succeeded in attaining its individuality as a hexagon.

Just below one of the quarries and very near the others is Mr. Kinkel's mill, where he grinds the spar for market to crockery makers. A "chasing mill" is used, and nothing inanimate could seem more human in movement than do these two ponderous stones that chase each other around a central pivot, bending a little toward each other and crunching each new shovelful of spar thrown between them, as some monster might crush the bones of a hapless victim. The spar all passes under two pairs of stones revolved by steam, and is thus reduced to a very fine powder. From these it passes into an iron cylinder, about four feet in diameter, on the floor below. The cylinder is half filled with very smooth, dark-blue quartz, pebbles, nearly as large as hen's eggs, imported from the coast of Norway. By the friction of the spar against these pebbles in the revolving cylinder, the complete pulverization is accomplished, and the powder is as fine as the finest flour. The process is so simple that we wonder it was ever thought of.

Close to this mill is a kiln, where Mr. Kinkel calcines quartz when he has an order for it. He has arranged a very simple and convenient device for fuel. A barrel of oil stands on the rocks a few feet above the furnace. The oil falls through a pipe into the mouth, where a fire of wood is first kindled; the oil is then lighted and the flame plays among the small pieces of quartz, calcining it about as fast as it can be fed into the opening above.

The woods about the quarries are very beautiful; the tall oaks and chestnuts bend above most luxuriant ferns of many varieties. At the foot of the hill, across the meadow, the Mianus flows gently along, carrying what Whittier has called its "small tribute" to the Sound. Its water is stayed here to turn the wheels for two mills, one where corn, grain, and spar are ground, the other a sawmill.

Sitting in the shade of an old orchard, beside the little river, far enough from the mills to find them rather picturesque features in the landscape, was by no means the least of the pleasures experienced by some members of the party of mineralogists.

A party of Mexicans and a diamond expert of Chicago have gone to the Balsas River region of the state of Guerrero, Mexico, where they expect to engage in diamond mining on an extensive scale.

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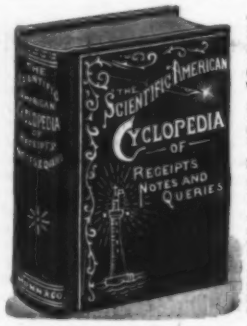

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